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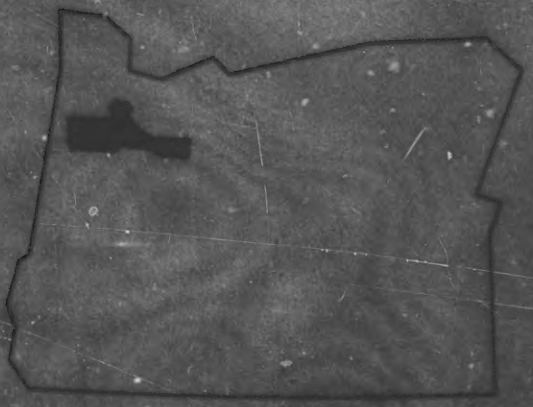
ORIGINAL

FLOOD INSURANCE STUDY



CITY OF SALEM, OREGON
MARION AND POLK COUNTIES

SEPTEMBER 4, 1986

Federal Emergency Management Agency

COMMUNITY NUMBER 410137

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TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
1.1	Purpose of Study	1
1.2	Authority and Acknowledgments	1
1.3	Coordination	1
2.0	AREA STUDIED	2
2.1	Scope of Study	2
2.2	Community Description	4
2.3	Principal Flood Problems	5
2.4	Flood Protection Measures	5
3.0	ENGINEERING METHODS	6
3.1	Hydrologic Analyses	6
3.2	Hydraulic Analyses	12
4.0	FLOOD PLAIN MANAGEMENT APPLICATIONS	16
4.1	Flood Boundaries	16
4.2	Floodways	17
5.0	INSURANCE APPLICATION	30
5.1	Reach Determinations	30
5.2	Flood Hazard Factors	30
5.3	Flood Insurance Zones	34
5.4	Flood Insurance Rate Map Description	34
6.0	OTHER STUDIES	35
7.0	LOCATION OF DATA	35
8.0	BIBLIOGRAPHY AND REFERENCES	36

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TABLE OF CONTENTS (Cont'd)

Page

FIGURES

Figure 1 - Vicinity Map..... 3
Figure 2 - Rating Curve, Shelton Ditch Diversion Structure..... 8
Figure 3 - Schematic of Computed 100-Year-Flood Peak Flows for Mill Creek..... 10
Figure 4 - Floodway Schematic..... 18

TABLES

Table 1 - Summary of Discharges..... 13
Table 2 - Floodway Data..... 19
Table 3 - Flood Insurance Zone Data..... 31

EXHIBITS

Exhibit 1 - Flood Profiles

Mill Creek	Panels 01P-08P
Mill Creek Overflow	Panels 09P-11P
Shelton Ditch	Panels 12P-14P
Pringle Creek	Panels 15P-16P
Middle Fork Pringle Creek	Panels 17P-18P
East Fork Pringle Creek	Panels 19P-21P
West Fork Pringle Creek	Panel 22P
Battle Creek	Panel 23P
Powell Creek	Panel 24P
Claggett Creek	Panels 25P-26P
Willamette River	Panels 27P-28P

Exhibit 2 - Flood Boundary and Floodway Map Index
Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

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1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study revises and updates a previous Flood Insurance Study for the City of Salem, Marion and Polk Counties, Oregon. This information will be used by Salem to update existing flood plain regulations as part of the regular phase of the National Flood Insurance Program (NFIP). The information will also be used by local and regional planners to further promote sound land use and flood plain development.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for the original study were performed by CH2M HILL, Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. H-3994. This work was completed in May 1981.

This revised Flood Insurance Study was prepared by Dames & Moore, under Contract No. C-0970, for Claggett Creek and East Fork Pringle Creek between cross sections X and AC. This work was completed in July 1985.

1.3 Coordination

An initial coordination meeting for the original study was held on November 8, 1979. An intermediate coordination meeting was held on January 20, 1981, to determine additional work. The meetings were attended by representatives of FEMA, the City of Salem, and the study contractor.

Base data for the original study were furnished by various organizations. The City of Salem Zoning Commission provided base maps showing street names and corporate limits. The Oregon State High-

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way Department provided plans and profiles of Interstate Highway 5 and State Highway 22. The Oregon Water Resources Department provided a rating table and discharge measurement notes for Mill Creek at Penitentiary Annex. The City of Salem provided field notes for a survey of the west bank dike along Mill Creek.

The final community coordination meeting for the original study was held on October 28, 1982, and was attended by representatives of FEMA, the city, and the study contractor. No objections were made to the study.

The revision to East Fork Pringle Creek was initiated on February 3, 1984, by the city; the revision to Claggett Creek was initiated on April 1, 1985, by FEMA. The final decision to prepare this Type 19 restudy was made by FEMA representatives on May 16, 1985.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated areas of the City of Salem, Marion and Polk Counties, Oregon. The area of study is shown on the Vicinity Map (Figure 1).

The flooding sources studied by detailed methods are Mill Creek, between its mouth and the upstream corporate limits; Mill Creek Overflow; Shelton Ditch, from the Willamette River to the Shelton Ditch diversion structure; Pringle Creek, between its confluence with Shelton Ditch and the confluence of the Middle and West Forks Pringle Creek; Middle Fork Pringle Creek, between its mouth and Interstate Highway 5; East Fork Pringle Creek, between its mouth and Interstate Highway 5; West Fork Pringle Creek, between its mouth and Fairview Hospital and Training Center; Battle Creek, upstream of Interstate Highway 5; Powell Creek; and Claggett Creek.

The Willamette River was studied by detailed methods as part of the previous Flood Insurance Study for the City of Salem (Reference 1) and the Flood Insurance Studies for the unincorporated areas of Marion and Polk Counties (References 2 and 3, respectively). Those analyses of the Willamette River have been included in this study.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development.

Gibson Gulch and Glenn Creek were studied by approximate methods.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and

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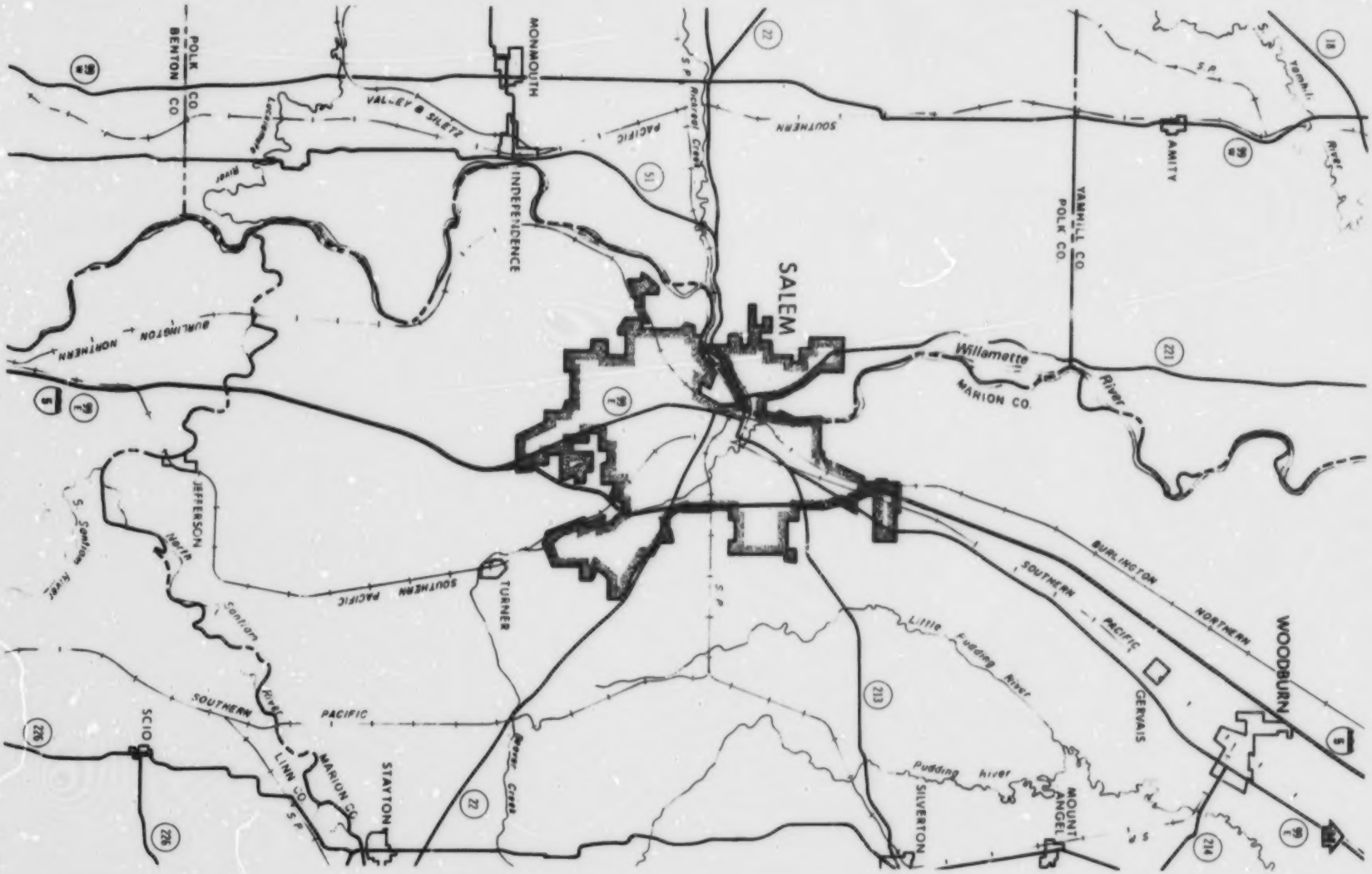

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

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methods of study were proposed to and agreed upon by FEMA and the City of Salem.

2.2 Community Description

The City of Salem is located in western Marion and eastern Polk Counties, along the Willamette River Valley in northwestern Oregon. The Willamette Valley was one of the earliest settled areas in the Pacific Northwest. It was frequently visited by fur trappers in the 1820s and 1830s, and large-scale emigration over the Oregon Trail began in 1843.

Marion County, the center of early missionary activity, was created by a provisional government legislative committee on July 5, 1843, 16 years before Oregon obtained statehood. The present county boundary, encompassing 1,175 square miles, was established in 1856. Salem was designated the county seat and later became the State capital. Polk County, created December 22, 1845, by a provisional legislative committee, contains 708 square miles.

The population of the area has expanded rapidly since World War II. Most of the increase has taken place near Salem. In 1979, the total population of Marion and Polk Counties was 237,000. Almost 40 percent of the population, about 89,000, lived in Salem (Reference 4). Salem is one of the fastest growing cities in Oregon. Population in Polk County, except for West Salem, has leveled off after rapid expansion following World War II.

The climate in Salem is a moderate marine-forest type, with mild winters and cool summers. The normal daily mean temperatures are a high of 66.6°F in July and a low of 38.8°F in January. Rainfall amounts to 41.08 inches yearly; snowfall totals 7.10 inches for the same period (Reference 5).

The Willamette River drains a total of 11,200 square miles in northwestern Oregon. The river, originating at the confluence of the Middle and Coast Forks just upstream from Eugene, meanders northward through the Willamette Valley a distance of 187 miles before discharging into the Columbia River north of Portland. Its tributaries originate in the foothills and mountains of the Coast and Cascade Ranges.

The Willamette Valley is a large intermountain basin situated between the Coast and Cascade Ranges. The valley has little relief, except for the Salem-Eola Hills complex at Salem, which is cut by the Willamette River. Summits of the Coast Range and Cascade Range vary in elevation from 1,000 to 3,000 feet and 5,000 to 10,000 feet, respectively.

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Salem has an incorporated area of approximately 34.5 square miles, which is platted on both banks of the Willamette River. Many small streams pass through Salem and empty into the Willamette River. Those streams include Mill Creek, Shelton Ditch, Croisan Creek, and Claggett Creek on the east bank, and Glenn Creek on the west bank.

2.3 Principal Flood Problems

The flood season at Salem extends from October through April. Most of the floods occur during December and January. Whenever the rainfall is abnormally intense or prolonged, the potential for flooding exists.

During the larger floods, heavy rainfall causes significant melting of accumulated snow in the Coast and Cascade Ranges. When the ground is frozen or saturated, runoff is greater and more rapid.

The largest flood of record on the Willamette River occurred in 1861. The peak 1861 flow was estimated to be 500,000 cubic feet per second (cfs) at Salem (Reference 6). Many large floods have occurred since then. The flood of December 1964, if not regulated, would have been the largest since 1861. The peak 1964 flow was 309,000 cfs at Salem. It was estimated that the peak 1964 flow would have been 472,000 cfs without any regulation by upstream reservoirs (Reference 7). Observed stages during the 1964 flood were considerably lower at Salem because seven flood-control storage dams (one on the North Santiam River and six on tributaries in the upper Willamette Basin) were operating at that time. However, flood elevations on the Willamette River at Salem were still high enough to cause extensive damage. The sewage plant was inundated, and downtown stores and hotels sustained damage from storm sewers backed up by high-river stages. Gravel operations and golf courses were damaged by silting and erosion. Extensive damage also occurred along Shelton Ditch, mostly downstream from Winter Street SE. Flooding in that area was mainly caused by Willamette River backwater. The Pringle Park area was inundated, necessitating evacuation of Salem Memorial Hospital. Additionally, offices, residences, and commercial establishments were flooded. Because of flow relief provided by Shelton Ditch, flooding along Mill Creek caused only minor damage in 1964. Backwater from the Willamette River was not a serious problem on Mill Creek.

2.4 Flood Protection Measures

In 1938, Congress authorized the Willamette River Basin Project, which provided for seven flood-control dams. In later years, four additional dams were authorized. These 11 multipurpose storage projects control runoff from approximately 42 percent of the Willamette River drainage area upstream from Salem. Although these

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projects significantly reduce flooding on the Willamette River at Salem, they do not eliminate it.

Some effort has been made to reduce flooding on Mill Creek. Shelton Ditch was built in 1936 to reduce Mill Creek flooding in the central part of Salem by diverting part of the Mill Creek streamflow to the Willamette River. Upstream of the Shelton Ditch diversion structure, limited protection is provided by private levees.

The U.S. Weather Bureau, River District Office, in Portland, Oregon, is responsible for the flood warning and river forecasting services in Marion and Polk Counties. River forecasts are issued daily for the Willamette River at Salem.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual occurrence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

Peak discharge-frequency relationships for the Willamette River were developed by the U.S. Army Corps of Engineers as part of the June 1979 Flood Insurance Study for the City of Salem (Reference 1) and the Flood Insurance Studies for the unincorporated areas of Marion and Polk Counties (References 2 and 3, respectively). Flood-frequency data were developed from maximum annual discharges of

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record adjusted on a regional basis where applicable. Records were obtained from the U.S. Geological Survey stream-gaging station on the Willamette River approximately 300 feet upstream from State Highway 22 (Center Street NE), with a period of record of 83 years.

Historical records for the flood of December 1964 along the Willamette River (Reference 8) were compared to high-water marks along Mill Creek. Peak flows along the Willamette River and Mill Creek were coincident during the 1964 flood. As a result, floodflows on Mill Creek and Shelton Ditch were assumed to be coincident with peak flows on the Willamette River for the purpose of this study.

Floodflow-frequency data for Mill Creek were based on the analysis of annual peak flows at Oregon Water Resources Department Mill Creek stream gage No. 14191500 at Penitentiary Annex. Twenty-nine annual peak flows, 19 from U.S. Geological Survey records from 1938 to 1956 (References 9 and 10) and 10 from Oregon Water Resources Department records from 1968 to 1977 (Reference 11), were fit to the log-Pearson Type III distribution with a zero skew coefficient (Reference 12).

At the Shelton Ditch diversion structure, part of the Mill Creek floodflow is diverted down Shelton Ditch. The Shelton Ditch diversion structure was studied to determine how the flow is divided between Mill Creek and Shelton Ditch. The diversion structure consists of a weir across Mill Creek and a weir across Shelton Ditch, separated by a wingwall. On the Mill Creek side of the structure, there is a 14-foot-wide central weir and two 5-foot-wide flashboard bays; on the Shelton Ditch side, there is a 44-foot-wide central weir, five 5-foot-wide flashboard bays, and a 5-foot-wide opening, without a weir, for fish passage. Several operating procedures for the diversion structure were investigated.

The U.S. Army Corps of Engineers step-backwater HEC-2 computer program (Reference 13) was used to develop a rating curve at the diversion structure. The structure was evaluated for three sets of operating conditions:

1. Flashboards in place on the Mill Creek side only

2. Flashboards in place on the Shelton Ditch side only

3. No flashboards in place on either side

The study concluded that placing the flashboards on the Shelton Ditch side would substantially increase the downstream Mill Creek flow over the condition of having no flashboards in place on either side. However, placing the flashboards on the Mill Creek side results in essentially the same downstream Mill Creek flow as with no-flashboards conditions. In fact, at flows greater than 2,200

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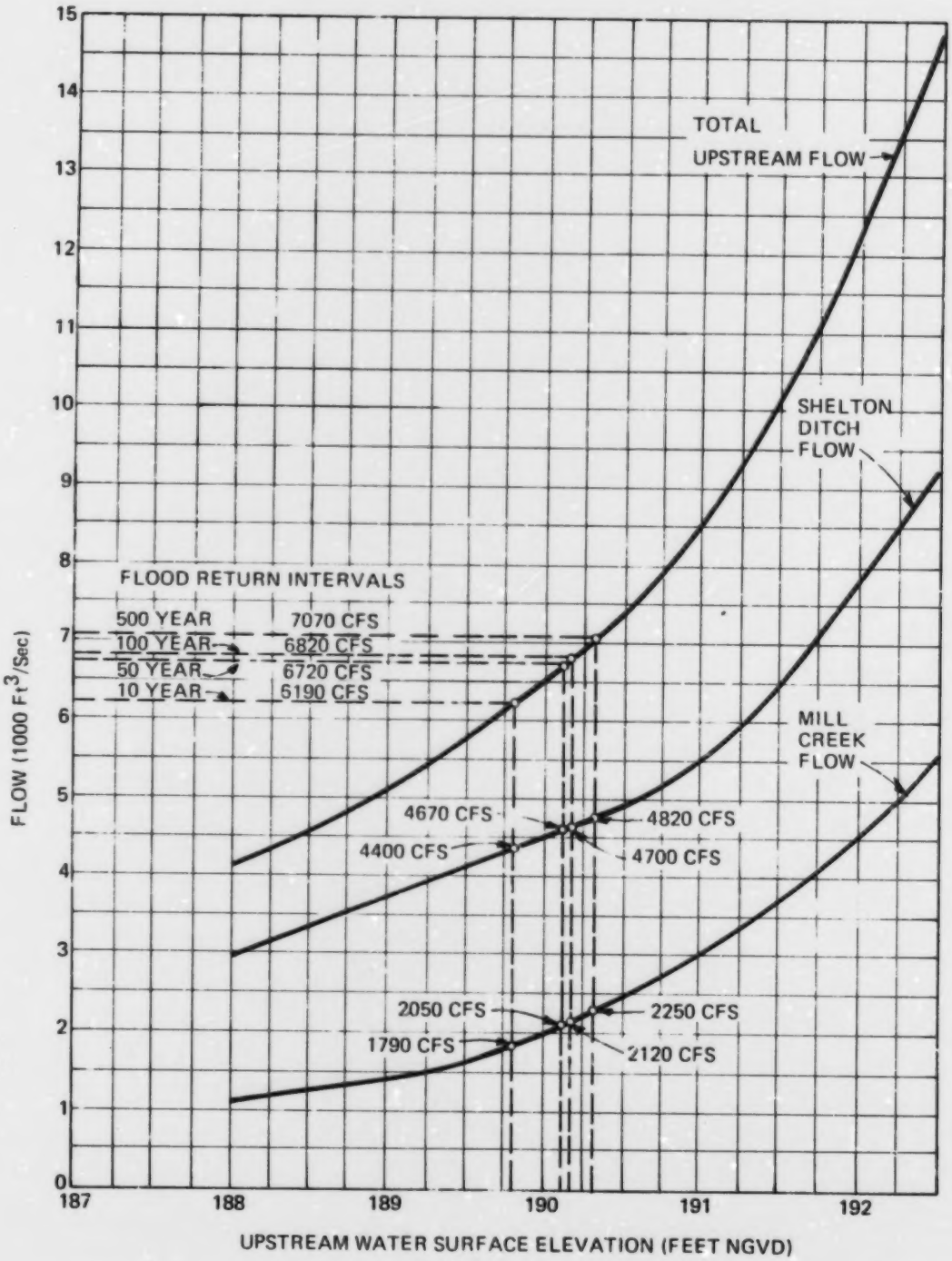

FIGURE 2

RATING CURVE
SHELTON DITCH DIVERSION STRUCTURE
(NO FLASHBOARDS)

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cfs, the flow going down Mill Creek is slightly greater with flashboards than with no flashboards. Under existing conditions, the flow down Mill Creek is minimized when no flashboards are in place.

Figure 2 shows the rating curve for the Shelton Ditch diversion structure for operating condition No. 3. The flow in Mill Creek and Shelton Ditch for the floods having recurrence intervals of 10, 50, 100, and 500 years are also shown.

The variation in peak flows entering the diversion structures for the 10-, 50-, 100-, and 500-year recurrence intervals is small (6,190 to 7,070 cfs) because of two large upstream overflows from Mill Creek during the 50-, 100-, and 500-year events. Negligible overflow occurs during the 10-year event.

One overflow leaves Mill Creek upstream of Interstate Highway 5, and flows through the Interstate Highway 5/Turner Road SE underpass and the Interstate Highway 5/Southern Pacific Railroad underpass, and into the East and Middle Forks Pringle Creek. The overflows along East and Middle Forks Pringle Creek combine into Pringle Creek and eventually flow into Shelton Ditch.

The other overflow leaves Mill Creek near the trailer park by Turner Road SE downstream of Interstate Highway 5, flows through the airport in the vicinity of Mission Ditch, and eventually reaches Shelton Ditch. This overflow is defined, for the purpose of this study, as Mill Creek Overflow. There is negligible overflow from Mill Creek to Mill Creek Overflow during the 10-year event.

Figure 3 is a schematic of the 100-year-flood peak flows resulting from Mill Creek in the Salem area.

Peak flows along Mill Creek Overflow were determined by rating curves from Mill Creek overflows that overtop Turner Road SE.

Overflow hydrographs from Mill Creek into the Pringle Creek basin and hydrographs for the existing urbanized Pringle Creek conditions were computed and presented in the Fairview Industrial Site Airport Flood Study, Draft, City of Salem, Oregon, prepared for the City of Salem, Oregon, in October 1980 (Reference 14). These 100-year flood hydrographs were compared to determine whether the overflows, urbanized flows, or a combination of overflows and urbanized flows, produced the highest peak flows throughout the Pringle Creek basin. The peak flows from the urbanized Pringle Creek basin and the peak overflows from Mill Creek into Pringle Creek determined for this flood insurance study were used to develop the hydrographs for the Fairview industrial site study. It was found that when the overflow into Pringle Creek occurs, the runoff from the urbanized basin has already peaked and essentially passed downstream; therefore, any combination of overflows and urbanized flows is negligible. This

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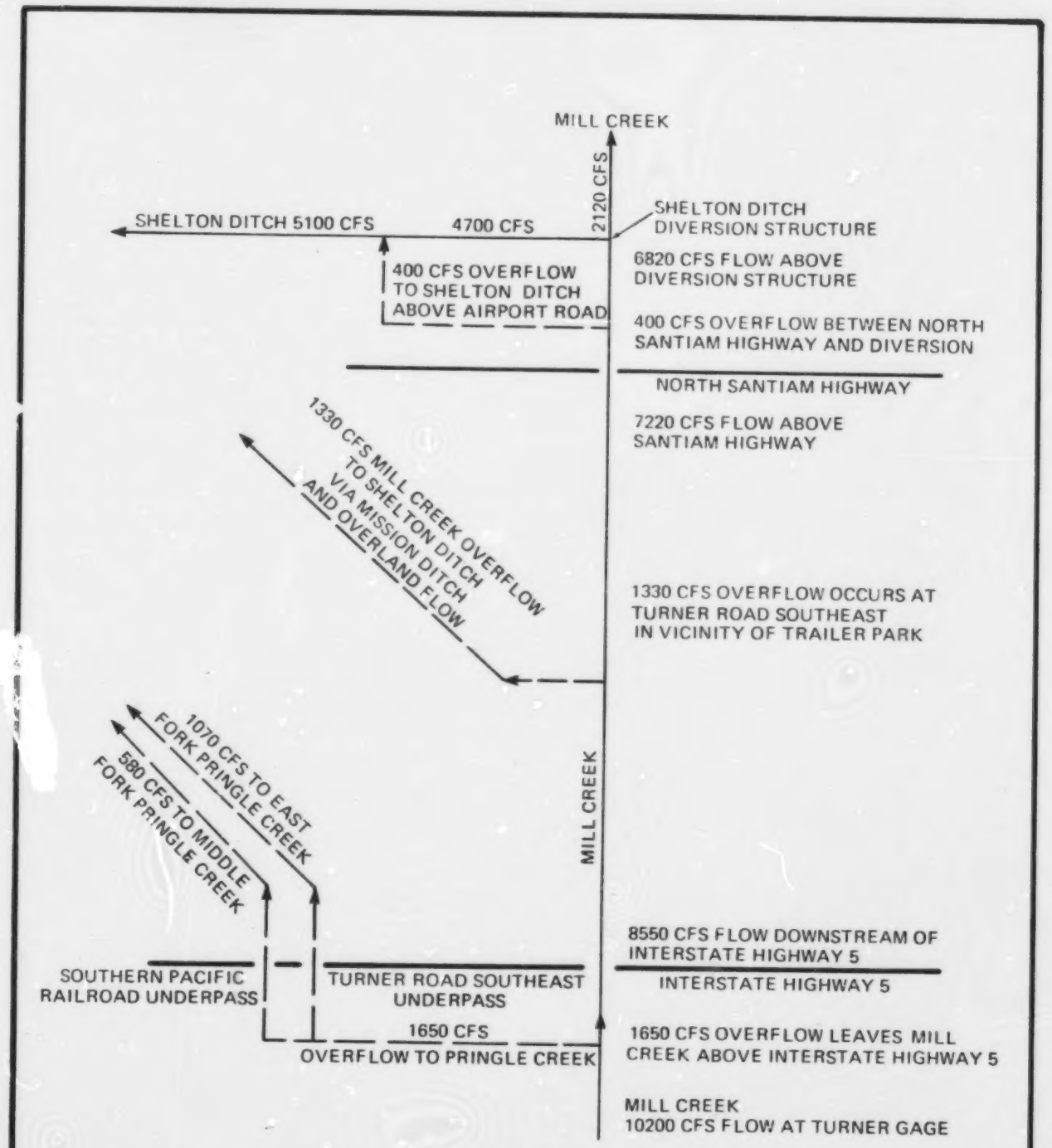

FIGURE 3
SCHEMATIC OF COMPUTED 100-YEAR
FLOOD PEAK FLOWS FOR MILL CREEK

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total hydrograph separation was also assumed to be valid for the 50- and 500-year events.

Peak flows from natural, nonurbanized runoff throughout the Pringle Creek drainage basin were based on the analysis of Oregon Water Resources Department Mill Creek stream gage No. 14191500 at Penitentiary Annex. For each frequency, the peak flows at the gage were transferred to Pringle Creek using the ratio of the drainage areas. The formula used was:

$$\frac{Q1}{Q2} = \left[\frac{A1}{A2}\right]^{0.95}$$

where Q1 = flow at gage
Q2 = flow at point of interest
A1 = drainage area at gage
A2 = drainage area at point of interest

Because the Pringle Creek basin has been urbanized, and the basin above the gage at Penitentiary Annex has not, the peak flows on Pringle Creek were increased to account for the effects of urbanization. The flows were increased by the method presented in An Approach to Estimating Flood Frequency for Urban Areas in Oklahoma by V.B. Sauer (Reference 15), which considers the percentages of storm-sewered and impervious areas in the urbanized basin.

Peak flows on the Middle and East Forks Pringle Creek are controlled by the overflows from Mill Creek during the 50-, 100-, and 500-year events. The peak 50-, 100-, and 500-year flows on Pringle Creek are controlled by urbanized flows between the West Fork confluence and the East Fork confluence, and between the Clark Creek confluence and the Shelton Ditch confluence. Between the East Fork confluence and the Clark Creek confluence, a combination of the East Fork and the Middle Fork overflow controls the peak flow. Floodflows along West Fork Pringle Creek are controlled by urbanized runoff, because there is no overflow from Mill Creek to West Fork Pringle Creek.

The peak-flow estimates for the urbanized runoff hydrographs along West Fork Pringle Creek were based on the regression technique for urbanized basins developed by V.B. Sauer (Reference 15).

Design discharge charts, presented in the Oregon State Highway Division Hydraulics Manual (Reference 16), were used to determine the peak flows on Battle Creek.

Natural peak flows on Powell Creek were determined by the transfer of Battle Creek flows using the formula cited earlier. The peak 50-, 100-, and 500-year flows on Powell Creek were then increased

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to account for overflow from Battle Creek downstream of Sunnyside Road SE.

For Claggett Creek, the 10-, 50-, and 100-year-flood peak discharges were developed by the Marion County Department of Public Works from unpublished discharge-frequency curves using a rainfall-runoff model developed and described by the U.S. Geological Survey (Reference 17). The 500-year-flood peak discharge was developed by extending the discharge-frequency curves on log-log paper.

Peak discharge-drainage area relationships for all streams studied in detail are shown in Table 1.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Water-surface elevations of floods of the selected recurrence intervals were computed using the U.S. Army Corps of Engineers step-backwater HEC-2 computer program (Reference 13).

Cross sections on Mill Creek, below the Shelton Ditch diversion structure; Claggett Creek; Pringle Creek; East Fork Pringle Creek; Middle Fork Pringle Creek; and West Fork Pringle Creek were field surveyed. Cross sections on the Willamette River; Shelton Ditch; and Mill Creek, above the Shelton Ditch diversion structure were obtained from the U.S. Army Corps of Engineers. Cross sections on Battle Creek, between Sunnyside Road and Interstate Highway 5, and on Powell Creek were taken from topographic maps at a scale of 1:1,200, with a contour interval of 2 feet (Reference 18). Cross sections on Mill Creek Overflow were scaled from topographic maps at a scale of 1:2,400, with a contour interval of 2 feet (Reference 19).

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Roughness factors (Manning's "n") were assigned on the basis of field inspection. The Manning's "n" values used for the rivers and creeks in this study are as follows:

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Table 1. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Willamette River					
At City of Salem	7,600	163,000	232,000	269,000	390,000
Mill Creek					
At Mouth	111	1,790[1]	2,050[1]	2,120[1]	2,250[1]
Above Shelton Ditch Diversion Structure	107.2	6,190	6,720[1]	6,820[1]	7,070[1]
Below Interstate Highway 5	104.4	6,190	7,850[1]	8,550[1]	10,300[1]
At Oregon Water Resources Department Gage No. 14191500 at Penitentiary Annex	104	6,190	8,950	10,200	13,300
Mill Creek Overflow					
Below Turner Road SE	---[2]	N/A	N/A	1,330[3]	N/A
Shelton Ditch					
At Mouth	---[2]	4,400	6,840	7,990	10,860
Above confluence with Pringle Creek	---[2]	4,400	4,920	5,100	5,450
Downstream of diversion structure	---[2]	4,400	4,670	4,700	4,820
Pringle Creek					
At confluence with Shelton Ditch	10.3	1,280[4]	1,700[4]	1,900[4]	3,260[4]
At 12th Street SE	7.3	720[4]	1,010[3]	1,510[3]	3,120[3]
At confluence of West Fork and Middle Fork Pringle Creek	5.7	650[4]	860[3]	970[3]	1,210[3]
Middle Fork Pringle Creek					
At Mouth	2.4	140[4]	340[3]	510[3]	940[3]

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Table 1. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
East Fork Pringle Creek					
At Mouth	1.4	70[4]	630[3]	955[3]	2,120[3]
West Fork Pringle Creek					
At Mouth	3.2	500[4]	650[4]	730[4]	880[4]
Battle Creek					
At Interstate Highway 5 (southbound)	9.8	590	870	990	1,310
At Sunnyside Road SE	5.4	330	490	555	730
Powell Creek					
At Mouth	0.7	46	78	113	148
Claggett Creek					
At Burlington Northern Railroad	7.6	690	890	950	1,080
At Interstate Highway 5	4.4	590	740	800	900

[1] Reduction in Discharge Due to Overflow Losses and/or Diversion
[2] Not Determined
[3] Overflow From Mill Creek
[4] Urbanized Runoff From Pringle Creek Basin

Flooding Source	Overbank	Channel
Willamette River	0.058 to 0.085	0.035 to 0.047
Mill Creek and Mill Creek Overflow	0.050 to 0.080	0.045 to 0.050
Shelton Ditch	0.040 to 0.080	0.025 to 0.060
Battle Creek	0.035 to 0.075	0.030 to 0.100
Claggett Creek	0.045	0.040
Powell Creek	0.045 to 0.070	0.022 to 0.090
Pringle Creek, East Fork Pringle Creek, Middle Fork Pringle Creek, and West Fork Pringle Creek	0.030 to 0.065	0.030 to 0.050

The starting water-surface elevations for the Willamette River were determined by the slope-area method, with the estimated slope of the energy grade line taken from the Willamette River profile. The starting water-surface elevations for Mill Creek and Shelton Ditch were taken from the Willamette River profiles. The starting water-surface elevations for Pringle Creek were taken from the Shelton Ditch profiles. Starting water-surface elevations for the East, Middle, and West Forks Pringle Creek were taken from the Pringle Creek profile. The starting water-surface elevations for Mill Creek, above the Shelton Ditch diversion structure, were taken from the rating curve at the diversion structure. Starting water-surface elevations for Mill Creek Overflow were determined by the slope-area method.

The starting water-surface elevations for Battle Creek were determined by an analysis of the flow restriction caused by the culverts under Interstate Highway 5. The U.S. Army Corps of Engineers HEC-1 computer program (Reference 20) was used to route the flood hydrograph through the culverts and determine the time variation in the ponded water-surface elevation upstream of the culverts. The starting water-surface elevations for Powell Creek were taken from the Battle Creek profiles.

The starting water-surface elevations for Claggett Creek were calculated using the normal-depth method.

Flood elevations in the community can be raised by debris blockage; the hydraulic analyses for this study, however, are based only on the effects of unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed and do not fail.

Generally, the distances on the flood profiles correspond to distances measured along the centerline of the designated watercourses. For Mill Creek Overflow and segments of Middle and East Forks Pringle Creek, however, the lack of any low-flow watercourses necessitated the use of distances measured along the centerline of the 100-year

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flow paths. On the maps, these flow lines, used to establish the respective profile distances, are delineated and labeled as Profile Base Lines.

For Mill Creek Overflow, only the 100-year elevations were computed. Therefore, the flood profiles for Mill Creek Overflow were drawn showing computed water-surface elevations for only the 100-year flood.

During the 100-year flood, water flows into a gravel pit along the right overbank of East Fork Pringle Creek at 22nd Street SE. The 100-year elevation in the gravel pit is controlled by a natural outlet located near cross section L.

Average depths for the areas of shallow flooding resulting from the overflows of Mill Creek, and along Battle and Powell Creeks, were determined using topographic maps (References 21, 18, and 19, respectively).

Approximate flooding areas for Gibson Gulch and Glenn Creek were determined by field survey and engineering judgment.

A private levee is located along Haul Road SE, east of Interstate Highway 5. Approximate flooding north of the levee was determined by calculating the amount of discharge in the right overbank of Mill Creek at the Interstate Highway 5 bridge opening. Normal-depth calculations were performed to determine the extent of flooding without consideration of the levee.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in the study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes maps designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each

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cross section. Between cross sections, the boundaries were interpolated using topographic maps at scales of 1:2,400, 1:6,000, 1:1,200, and 1:24,000, with contour intervals of 2, 4, 2, and 10 feet (References 19, 21, 18, and 22, respectively), and aerial photographs at a scale of 1:12,000 (Reference 23).

The 100-year flood plain boundaries for areas of shallow flooding were delineated using topographic maps (References 18, 19, and 22), based on elevations determined by methods discussed in Section 3.2.

The approximate 100-year flood plain boundaries for Gibson Gulch and Glenn Creek were delineated using topographic maps at a scale of 1:24,000, with a contour interval of 10 feet (Reference 22), based on elevations determined by the methods discussed in Section 3.2. Approximate 100-year flood plain boundaries north of the private levee, located east of Mill Creek and Interstate Highway 5, were delineated using topographic maps at a scale of 1:2,400, with a contour interval of 2 feet (Reference 19), based on elevations determined by the methods described in Section 3.2. Approximate flood plain boundaries in some portions of the study area were taken from the June 1979 Flood Insurance Study prepared for the City of Salem (Reference 1).

The 100- and 500-year flood plain boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100-and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the flooding sources studied by approximate methods, only the 100-year flood plain boundary is shown.

4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces the flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the NFIP, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

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Because of the scope of the study, no floodways have been determined for Shelton Ditch, West Fork Pringle Creek, and Mill Creek, and downstream of the Shelton Ditch diversion overflow.

No floodway has been presented along East Fork Pringle Creek between cross sections E and F. A floodway is inappropriate for lake conditions because of lack of conveyance.

The floodways presented in this study were computed on the basis of equal-conveyance reduction from each side of the flood plain.

The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 2).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the the floodway and 100-year flood plain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year flood plain boundaries is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 4.

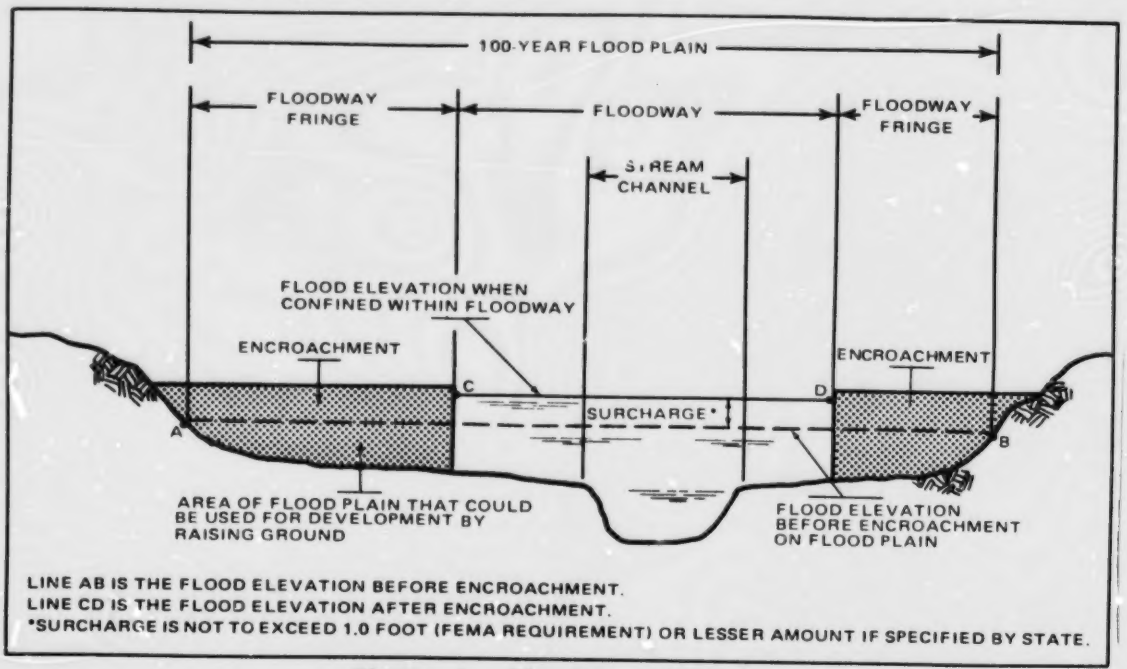
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

Figure 4. Floodway Schematic

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Mill Creek								
AV	19,678	250/120[2]	1,379	5.2	190.2	190.2	191.2	1.0
AW	19,968	421/125[2]	1,979	3.6	191.0	191.0	192.0	1.0
AX	21,668	232/200[2]	1,753	4.1	193.6	193.6	194.4	0.8
AY	23,093	164	1,027	7.0	196.4	196.4	197.2	0.8
AZ	23,228	180	1,204	6.0	197.8	197.8	198.1	0.3
BA	23,728	390[3]	2,706	2.7	198.6	198.6	199.4	0.8
BB	24,348	570[3]	3,352	2.2	198.8	198.8	199.7	0.9
BC	24,968	1,003[3]	1,338	5.4	200.1	200.1	201.0	0.9
BD	25,295	1,190[3]	2,657	2.7	202.3	202.3	203.3	1.0
BE	25,546	1,190	5,389	1.3	203.2	203.2	204.0	0.8
BF[4]	25,721	1,117	2,834	2.5	203.3	203.3	204.0	0.7
BG[4]	26,581	852	2,368	3.0	205.0	205.0	205.5	0.5
BH[4]	27,231	650	2,395	3.0	206.6	206.6	207.3	0.7
BI[4]	27,881	694[5]	1,677	4.3	209.9	209.9	210.9	1.0
BJ[4]	29,231	1,470[5]	1,698	4.8	213.8	213.8	214.2	0.4
BK	29,681	1,480[5]	3,099	2.7	215.3	215.3	215.9	0.6
BL	31,131	125	1,204	7.1	219.6	219.6	220.3	0.7
BM	31,781	91	866	9.9	222.3	222.3	222.5	0.2
BN	31,971	91[2]	1,044	8.2	224.3	224.3	224.5	0.2
BO	32,171	191/70[2]	1,634	5.2	225.9	225.9	225.9	0.0
BP	32,946	1,532/230[2]	7,092	1.4	226.3	226.3	226.9	0.6
BQ	33,746	1,410/70[2]	4,619	2.2	226.6	226.6	227.3	0.7
BR	34,021	1,494/70[2]	4,441	2.3	227.0	227.0	227.8	0.8

[1]Feet Above Mouth [2]Width/Width Within Corporate Limits [3]Width Includes Islands of Zone C [4]Cross Section is Common With Mill Creek Overflow [5]Width Includes Mill Creek Overflow Floodway

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

FLOODWAY DATA

MILL CREEK

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Mill Creek (Cont'd)								
BS	35,746	1,327/500[2]	3,048	3.3	231.1	231.1	231.7	0.6
BT	36,796	1,350/800[2]	4,596	2.2	233.2	233.2	234.2	1.0
BU	37,961	1,053/320[2]	1,854	5.5	236.4	236.4	237.0	0.6
BV	38,536	983[3]	2,182	4.7	239.7	239.7	240.3	0.6
BW	38,567	983	2,485	4.1	240.6	240.6	240.6	0.0
BX	39,082	640	3,111	3.3	241.7	241.7	242.0	0.3
BY	39,932	401	2,303	4.4	242.6	242.6	243.1	0.5
BZ	40,642	432	2,218	4.6	244.1	244.1	244.9	0.8
CA	41,767	462	2,636	3.9	246.6	246.6	247.5	0.9
CB	41,956	628	3,127	3.3	247.1	247.1	248.0	0.9
CC	43,606	489	1,715	5.9	249.4	249.4	250.0	0.6
CD	45,886	1,334/1,140[2]	3,658	2.8	256.6	256.6	257.6	1.0

[1]Feet Above Mouth [2]Width/Width Within Corporate Limits [3]Width Includes Islands of Zone C

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

FLOODWAY DATA

MILL CREEK

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Mill Creek Overflow								
A	330	330	402	3.3	166.1	166.1	167.1	1.0
B	620	350	873	1.5	168.4	168.4	169.4	1.0
C	1,370	350	772	1.7	170.8	170.8	171.8	1.0
D	2,120	320	526	2.5	172.6	172.6	173.3	0.7
E	2,330	350	600	2.2	172.9	172.9	173.6	0.7
F	2,910	280	247	5.4	176.0	176.0	176.4	0.4
G	3,290	390	844	1.6	178.8	178.8	179.8	1.0
H	3,750	620[2]	1,036	1.3	180.0	180.0	181.0	1.0
I	4,460	455	899	1.5	180.8	180.8	181.8	1.0
J	5,220	240	274	4.9	182.2	182.2	182.8	0.6
K	5,590	260	404	3.3	184.2	184.2	184.5	0.3
L	6,530	149	483	2.8	185.2	185.2	185.7	0.5
M	7,075	200	222	6.0	186.4	186.4	186.4	0.0
N	7,885	245	420	3.2	189.9	189.9	190.2	0.3
O	8,585	230	255	5.2	192.5	192.5	192.7	0.2
P	9,825	300	552	2.4	195.5	195.5	196.1	0.6
Q	10,605	200	299	4.5	197.0	197.0	197.4	0.4
R	11,145	195	345	3.9	198.8	198.8	199.5	0.7
S	11,725	205	325	4.1	200.9	200.9	201.4	0.5
T	12,325	200	316	4.2	203.1	203.1	203.7	0.6
BG[3]	12,755	200	265	4.7	205.3	205.3	205.7	0.4
BH[3]	13,175	200	433	3.1	206.4	206.4	207.0	0.6
BI[3]	13,735	195[4]	380	3.5	207.7	207.7	208.1	0.4
BJ[3]	14,950	1,470[4]	271	1.8	210.7	210.7	211.0	0.3
BK[3]	15,180	1,480[4]	74	3.3	212.5	212.5	212.5	0.0

[1]Feet Above Confluence With Shelton Ditch [2]Width Includes Island of Zone B [3]Cross Section is Common with Mill Creek [4]Width Includes Mill Creek Floodway

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

FLOODWAY DATA

MILL CREEK OVERFLOW

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Pringle Creek								
A	1,250	41	309	6.2	148.8	145.3[2]	146.3[2]	1.0
B	1,300	41	365	5.2	148.9	146.7[2]	147.7[2]	1.0
C	1,375	41	357	5.3	148.9	146.8[2]	147.7[2]	0.9
D	1,810	57	394	4.8	149.1	148.0[2]	148.5[2]	0.5
E	1,930	57	379	4.8	149.2	148.8[2]	148.8[2]	0.0
F	2,720	54	254	7.1	151.0	151.0	151.2	0.2
G	4,320	37	193	8.1	160.7	160.7	160.7	0.0
H	4,370	37	212	7.3	161.5	161.5	161.5	0.0
I	5,120	37	160	9.7	165.5	165.5	165.5	0.0
J	5,270	37	165	9.4	166.7	166.7	166.7	0.0
K	5,370	40	306	5.1	168.2	168.2	168.2	0.0
L	5,470	40	299	5.2	168.8	168.8	168.8	0.0
M	5,750	30	228	6.8	169.0	169.0	169.0	0.0
N	5,810	30	257	6.1	169.9	169.9	169.9	0.0
O	6,290	37	203	7.4	170.7	170.7	170.9	0.2
P	6,400	38	219	6.9	171.0	171.0	172.0	1.0
Q	6,940	60	106	9.3	175.3	175.3	175.3	0.0
R	7,190	60	207	4.8	176.8	176.8	177.7	0.9
S	7,330	60	261	3.8	178.8	178.8	178.8	0.0
T	7,810	80	194	5.1	179.3	179.3	179.9	0.6
U	8,240	40	132	7.5	181.9	181.9	182.2	0.3
V	8,380	67	207	4.8	183.1	183.1	183.4	0.3
W	9,560	26	144	6.9	187.1	187.1	188.0	0.9
X	10,790	46	248	4.0	190.6	190.6	191.4	0.8
Y	10,870	78	254	3.9	191.4	191.4	192.3	0.9

[1]Feet Above Mouth [2]Elevation Computed Without Consideration of Influence From Shelton Ditch

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

FLOODWAY DATA

PRINGLE CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Middle Fork Pringle Creek								
A	275	37	150	3.4	192.9	192.9	193.5	0.6
B	980	32	81	6.3	194.7	194.7	195.4	0.7
C	1,820	31	105	4.9	199.5	199.5	200.2	0.7
D	1,870	31	180	2.8	202.8	202.8	202.8	0.0
E	2,350	74	207	2.5	202.9	202.9	203.3	0.4
F	2,400	74	198	2.6	202.9	202.9	203.3	0.4
G	3,390	75	190	2.7	203.6	203.6	204.3	0.7
H	4,540	30	82	7.1	207.0	207.0	207.0	0.0
I	5,690	50	160	3.6	210.8	210.8	211.6	0.8
J	7,105	68	186	3.1	213.4	213.4	214.0	0.6
K	8,520	57	183	3.2	215.5	215.5	216.3	0.8
L	9,935	13	51	11.3	221.7	221.7	221.7	0.0

[1] Feet Above Confluence With Pringle Creek and West Fork Pringle Creek

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

FLOODWAY DATA

MIDDLE FORK PRINGLE CREEK

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
East Fork Pringle Creek								
A	110	33	190	5.0	172.5	172.5	172.9	0.4
B	140	34	205	4.7	173.2	173.2	173.6	0.4
C	920	17	107	9.0	175.0	175.0	175.2	0.2
D	950	67	332	2.9	177.9	177.9	178.1	0.2
E	2,020	54	299	3.2	178.6	178.6	179.2	0.6
F	3,295	60	316	3.0	181.0	181.0	182.0	1.0
G	3,595	25	144	6.7	181.6	181.6	182.3	0.7
H	3,695	25	148	6.5	183.0	183.0	183.0	0.0
I	4,215	70	299	3.2	183.2	183.2	183.9	0.7
J	4,515	150	328	2.9	183.3	183.3	184.2	0.9
K	4,540	150	369	2.6	184.4	184.4	184.5	0.1
L	4,690	50	243	4.0	184.7	184.7	184.8	0.1
M	5,020	57	117	8.2	185.8	185.8	185.9	0.1
N	5,280	26	174	5.5	187.9	187.9	188.0	0.1
O	5,540	27	140	6.9	188.6	188.6	188.8	0.2
P	6,140	27	185	5.2	190.9	190.9	191.1	0.2
Q	6,740	41	238	4.0	191.7	191.7	192.2	0.5
R	7,060	100	259	3.7	192.1	192.1	192.7	0.6
S	7,100	100	283	3.4	192.2	192.2	192.8	0.6
T	7,710	109	446	2.2	194.6	194.6	195.4	0.8
U	7,765	107	382	2.5	194.6	194.6	195.4	0.8
V	8,565	42	207	4.6	195.5	195.5	196.5	1.0
W	9,145	42	212	4.5	196.9	196.9	197.9	1.0
X	9,695	33	137	7.0	198.1	198.1	199.1	1.0
Y	9,920	35	154	6.3	199.3	199.3	200.3	1.0
Z	10,185	36	164	5.8	200.2	200.2	201.2	1.0

[1]Feet Above Confluence With Pringle Creek

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

FLOODWAY DATA

EAST FORK PRINGLE CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
East Fork Pringle Creek (Cont'd)								
AA	10,685	33	166	5.8	201.6	201.6	202.6	0.1
AB	10,845	38	188	5.1	202.1	202.1	203.1	0.1
AC	11,995	57	235	4.6	205.3	205.3	206.3	1.0
AD	12,665	216	557	1.9	206.5	206.5	207.5	1.0
AE	12,945	173	435	2.5	206.8	206.8	207.7	0.9
AF	13,035	158	309	3.5	208.7	208.7	208.8	0.1
AG	14,535	100[2]	276	3.9	211.7	211.7	212.3	0.6
AH	15,945	170[2]	333	3.2	215.4	215.4	216.2	0.8
AI	17,385	600[2]	677	1.6	218.5	218.5	218.8	0.3

[1]Feet Above Confluence With Pringle Creek [2]Width Includes Island of Zone C

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

FLOODWAY DATA

EAST FORK PRINGLE CREEK

BEST COPY AVAILABLE

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Battle Creek								
A	22,200	60	354	2.8	381.8	381.8	382.8	1.0
B	22,719	179	482	2.1	382.7	382.7	383.5	0.8
C	23,409	65	306	3.2	384.1	384.1	384.8	0.7
D	23,514	61	339	2.9	384.1	384.1	385.1	1.0
E	23,714	152	831	1.2	384.4	384.4	385.3	0.9
F	24,221	107	574	1.7	384.5	384.5	385.4	0.9
G	24,328	41	284	3.3	384.5	384.5	385.4	0.9
H	24,383	41	291	3.3	384.7	384.7	385.6	0.9
I	24,536	60	247	3.8	385.3	385.3	386.0	0.7
J	24,756	133	402	2.4	385.7	385.7	386.5	0.8
K	25,136	260[2]	662	1.4	385.8	385.8	386.8	1.0
L	25,418	290[2]	499	1.8	385.8	385.8	386.8	1.0
M	25,838	250[2]	345	1.7	386.8	386.8	387.6	0.8
N	26,153	200[2]	170	3.5	388.2	388.2	388.2	0.0
O	26,493	179	175	3.4	389.5	389.5	390.0	0.5
P	26,675	61	146	4.1	390.8	390.8	391.2	0.4
Q	26,755	42	148	4.0	391.5	391.5	392.1	0.6
R	26,945	80	225	2.6	392.8	392.8	393.6	0.8
S	27,000	80	223	2.7	392.9	392.9	393.8	0.9
T	27,070	80	224	2.7	393.0	393.0	393.7	0.7
U	27,120	72	181	3.3	393.1	393.1	393.9	0.8
V	27,440	100	268	2.2	394.9	394.9	395.2	0.3
W	27,890	150[3]	187	3.2	396.6	396.6	397.0	0.4
X	28,220	273[3]	500	1.2	397.8	397.8	398.7	0.9
Y	28,284	293[3]	150	3.9	397.8	397.8	398.7	0.9

[1]Feet Above Mouth [2]Width Includes Island of Zone B and C [3]Width Includes Island of Zone B

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

FLOODWAY DATA

BATTLE CREEK

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Powell Creek								
A	400	30	35	2.2	386.8	386.8	387.8	1.0
B	660	30	131	0.6	388.2	388.2	388.2	0.0
C	960	37	89	0.9	388.3	388.3	388.3	0.0
D	1,080	19	22	3.6	388.5	388.5	388.5	0.0
E	1,140	8	25	3.1	389.9	389.9	389.9	0.0
F	1,195	20	46	1.7	389.9	389.9	389.9	0.0
G	1,370	14	23	3.3	389.9	389.9	389.9	0.0
H	1,420	6	12	6.3	389.9	389.9	389.9	0.0
I	1,482	6	16	4.8	391.0	391.0	391.0	0.0
J	1,536	42	60	1.3	391.4	391.4	391.4	0.0
K	1,871	13	13	5.8	393.3	393.3	393.3	0.0
Willamette River								
A	422,670	2,969[2]	56,800	4.74	134.1	134.1	134.5	0.4
B	434,170	3,613/920[3]	51,870	5.19	137.9	137.9	138.6	0.7
C	439,020	2,570/1,920[3]	49,133	5.47	140.1	140.1	140.9	0.8
D	443,220	1,290	39,581	6.80	142.3	142.3	143.0	0.7
E	445,020	2,485/460[3]	62,653	4.29	143.2	143.2	143.8	0.6
F	449,020	4,405/405[3]	86,932	3.09	144.4	144.4	145.0	0.6
G	451,020	4,950/4,210[3]	103,160	2.61	144.8	144.8	145.3	0.5

[1]Feet Above Mouth

[2]Floodway Lies Entirely Outside Corporate Limits

[3]Width/Width Within Corporate Limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

FLOODWAY DATA

POWELL CREEK - WILLAMETTE RIVER

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Willamette River (Cont'd)								
H	452,930	5,130/3,670[2]	87,316	3.08	144.9	144.9	145.5	0.6
I	455,090	4,800/4,040[2]	86,158	3.12	145.3	145.3	145.8	0.5
J	456,305	4,650/2,330[2]	76,469	3.52	145.5	145.5	146.0	0.5
K	457,890	5,200/1,570[2]	81,487	3.30	145.8	145.8	146.3	0.5

[1]Feet Above Mouth [2]Width/Width Within Corporate Limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

FLOODWAY DATA

WILLAMETTE RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Claggett Creek								
A	21,985	33	218	4.4	130.9	130.9	131.8	0.9
B	22,285	70	239	4.0	131.7	131.7	132.4	0.7
C	22,315	77	279	3.4	131.9	131.9	132.9	1.0
D	22,515	160	579	1.6	132.5	132.5	133.2	0.7
E	24,515	222	451	2.1	137.2	137.2	137.7	0.5
F	24,865	12	68	13.9	138.9	138.9	138.9	0.0
G	24,965	12	81	11.7	141.2	141.2	141.2	0.0
H	25,215	68	386	2.5	144.4	144.4	144.4	0.0
I	26,095	43	208	4.6	145.0	145.0	145.0	0.0
J	26,395	16	119	6.7	145.0	145.0	145.0	0.0
K	26,535	16	131	6.1	147.4	147.4	147.4	0.0
L	26,735	46	254	3.1	148.2	148.2	148.2	0.0
M	27,775	31	165	4.9	149.2	149.2	149.2	0.0
N	27,975	10	71	11.3	149.2	149.2	149.2	0.0
O	28,057	10	74	10.8	150.1	150.1	150.3	0.2
P	28,347	38	255	3.1	152.4	152.4	153.0	0.6
Q	28,557	14	111	7.2	152.5	152.5	153.1	0.6
R	28,661	14	122	6.6	153.5	153.5	154.2	0.7
S	28,711	39	266	3.0	154.4	154.4	155.0	0.6
T	29,751	53	166	4.8	155.6	155.6	155.9	0.3
U	29,861	23	126	6.4	156.1	156.1	156.2	0.1
V	29,991	91	371	2.2	159.4	159.4	159.4	0.0
W	30,061	10	78	10.3	159.4	159.4	159.4	0.0
X	30,191	10	151	5.3	166.5	166.5	166.5	0.0

[1]Feet Above Mouth

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

FLOODWAY DATA

CLAGGETT CREEK

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5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail affecting the City of Salem.

5.1 Reach Determinations

Reaches are defined as sections of flood plain having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the flooding sources of Salem are shown on the Flood Profiles (Exhibit 1) and summarized in Table 3.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish acturial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION (FEET NGVD)[3]
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
Mill Creek							
Reach 1	0004	-6.2	-1.9	4.7	060	A12	Varies - See Map
Reach 2	0004	-5.4	-1.6	4.1	055	A11	Varies - See Map
Reach 3	0004	-3.8	-1.3	3.7	040	A8	Varies - See Map
Reach 4	0004,0005	-1.2	-0.3	0.7	010	A2	Varies - See Map
Reach 5	0005,0008 0013	-0.5	-0.1	0.2	005	A1	Varies - See Map
Reach 6	0008,0012	-1.1	-0.3	0.6	010	A2	Varies - See Map
Shallow Flooding	0012	N/A	N/A	N/A	N/A	A0	Depth 1
Mill Creek Overflow							
Reach 1	0007,0008	-1.2[4]	N/A	N/A	010	A2	Varies - See Map
Reach 2	0008	-2.3[4]	N/A	N/A	025	A5	Varies - See Map
Shelton Ditch							
Reach 1	0004	-6.6	-2.0	5.2	065	A13	Varies - See Map
Reach 2	0004,0007	-3.7	-1.5	3.9	055	A11	Varies - See Map
Reach 3	0004,0007 0008	-2.6	-0.8	1.9	025	A5	Varies - See Map
Reach 4	0008	-0.9	-0.2	0.4	010	A2	Varies - See Map
Pringle Creek							
Reach 1	0004,0007	-4.0	-1.2	3.8	040	A8	Varies - See Map
Reach 2	0007	-1.5	-0.6	2.6	015	A3	Varies - See Map
Reach 3	0007	-2.3	-1.1	4.2	025	A5	Varies - See Map
Reach 4	0007	-0.9	-0.2	0.6	010	A2	Varies - See Map
Shallow Flooding	0007,0008	N/A	N/A	N/A	N/A	A0	Depth 1

[1]Flood Insurance Rate Map Panel [2]Weighted Average [3]Rounded to Nearest Foot
[4]Elevation Difference Between 100-Year and Ground

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

FLOOD INSURANCE ZONE DATA

MILL CREEK-MILL CREEK OVERFLOW-SHELTON DITCH-PRINGLE CREEK

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION (FEET NGVD)[3]
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
Middle Fork Pringle Creek							
Reach 1	0008	-0.9	-0.2	0.6	010	A2	Varies - See Map
Reach 2	0008,0012	-3.3	-0.7	0.8	035	A7	Varies - See Map
East Fork Pringle Creek							
Reach 1	0007	-2.4	-1.5	4.3	025	A5	Varies - See Map
Reach 2	0007	-4.0	-1.7	3.6	040	A8	Varies - See Map
Reach 3	0007,0008	-5.3	-1.7	3.3	055	A11	Varies - See Map
Reach 4	0008	-6.0	-1.0	1.9	060	A12	Varies - See Map
Reach 5	0008,0012	-4.9	-0.4	0.8	050	A10	Varies - See Map
Shallow Flooding	0007,0008	N/A	N/A	N/A	N/A	A0	Depth 1
West Fork Pringle Creek							
Reach 1	0008	-0.5	-0.1	0.3	005	A1	Varies - See Map
Battle Creek							
Reach 1	0011,0012	-0.9	-0.2	0.7	010	A2	Varies - See Map
Reach 2	0011,0012	-0.6	-0.2	0.4	005	A1	Varies - See Map
Shallow Flooding	0012	N/A	N/A	N/A	N/A	A0	Depth 1
Powell Creek							
Reach 1	0012	-1.6	-0.7	0.4	015	A3	Varies - See Map
Reach 2	0012	-0.5	-0.1	0.3	005	A1	Varies - See Map

[1]Flood Insurance Rate Map Panel [2]Weighted Average [3]Rounded to Nearest Foot

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

FLOOD INSURANCE ZONE DATA

MIDDLE FORK PRINGLE CREEK-EAST FORK PRINGLE CREEK-WEST FORK PRINGLE CREEK-BATTLE CREEK-POWELL CREEK

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION (FEET NGVD)[3]
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
Claggett Creek							
Reach 1	0003	-0.9	-0.01	0.3	010	A2	Varies - See Map
Reach 2	0003	-1.6	-0.2	1.37	015	A3	Varies - See Map
Reach 3	0003	-3.4	-1.1	0.3	035	A7	167
Willamette River							
Reach 1	0002,0004 0006,0007	-6.2	-1.9	4.7	060	A12	Varies - See Map

[1]Flood Insurance Rate Map Panel [2]Weighted Average [3]Rounded to Nearest Foot

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

FLOOD INSURANCE ZONE DATA

CLAGGETT CREEK-WILLAMETTE RIVER

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5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.
Zone A0:	Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; depths are shown, but no FHFs are determined.
Zones A1, A2, A3, A5, A7, A8, A10, A11, A12, A13, and A18:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; with base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other water-control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flood hazard; not subdivided.

The flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community are summarized in Table 3.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Salem is, for insurance purposes, the principal product of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of

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the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the NFIP.

6.0 OTHER STUDIES

Flood Insurance Studies have been prepared for the unincorporated areas of Marion and Polk Counties (References 2 and 3, respectively) and for the City of Salem (Reference 1). Detailed flooding along the Willamette River and some of the approximate 100-year flood boundaries within Salem have been included in this study from the previous Flood Insurance Studies.

Flood boundaries and elevations along Mill Creek do not reflect adjacent Mill Creek flooding as determined for the Marion County Flood Insurance Study. This is due to the reanalysis of Mill Creek overflows for the City of Salem. However, the Flood Insurance Study for the unincorporated areas of Marion County is being updated and revised to incorporate the reanalysis of Mill Creek as well as detailed analyses of Claggett, Battle, and Powell Creeks so that these studies will be in general agreement.

The 100-year flood boundaries and elevations along the Willamette River are in agreement with the boundaries determined for the Polk County Flood Insurance Study. In some areas, the 500-year flood boundaries do not agree because of scale differences and limitations. The Willamette River in the Polk County Flood Insurance Study does not include a floodway because of the limited scope of study. In all other areas, however, the two studies are in general agreement.

A 1980 flood report, Fairview Industrial Site Airport Flood Study, prepared by CH2M HILL, Inc., includes an analysis of Mill Creek overflows within the City of Salem (Reference 14). This Mill Creek analysis was incorporated into the Flood Insurance Study for Salem.

The U.S. Army Corps of Engineers published a 1968 report, Flood Plain Information, Willamette River and Tributaries in Marion and Polk Counties, Oregon (Reference 6). Some of the analysis of the Willamette River was determined from this report and was included in the Flood Insurance Studies for the City of Salem and the unincorporated areas of Marion and Polk Counties.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, Federal Regional Center, 130 228th Street, SW, Bothell, Washington 98021-9796.

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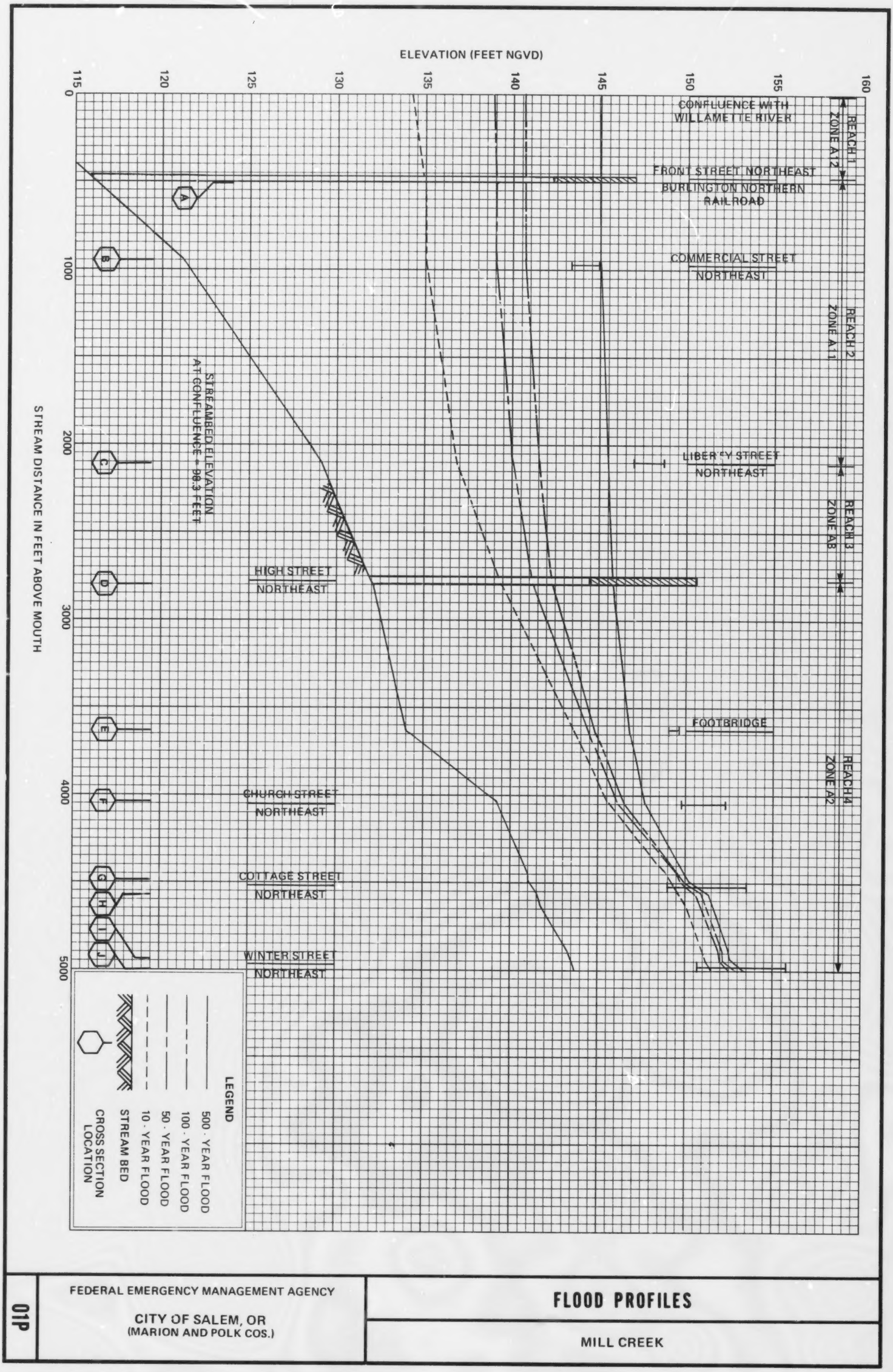

01P	FEDERAL EMERGENCY MANAGEMENT AGENCY CITY OF SALEM, OR (MARION AND POLK COS.)	FLOOD PROFILES MILL CREEK

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FLOOD PROFILES

MILL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

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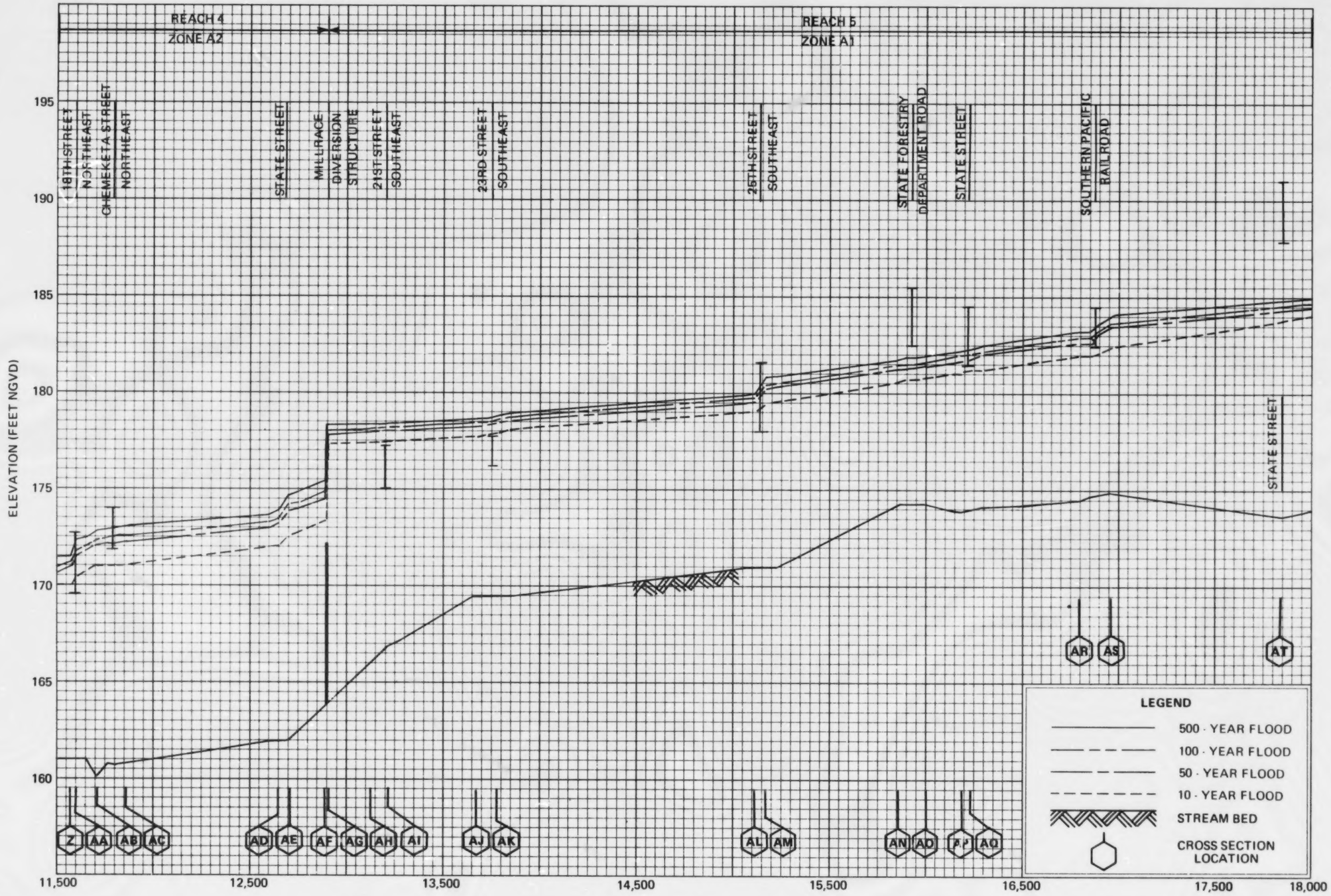

FLOOD PROFILES

MILL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

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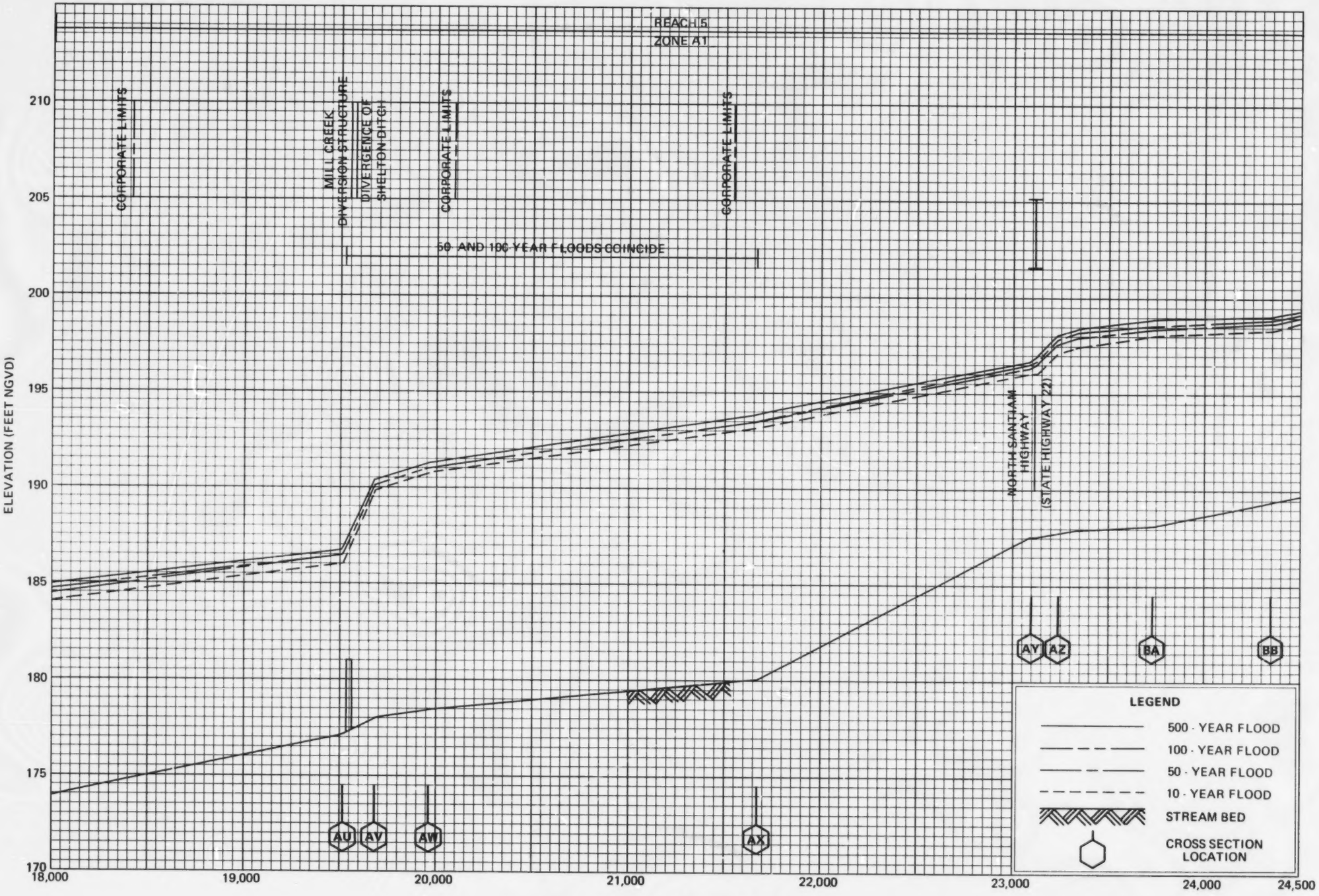

FLOOD PROFILES

MILL CREEK

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CITY OF SALEM, OR
(MARION AND POLK COS.)

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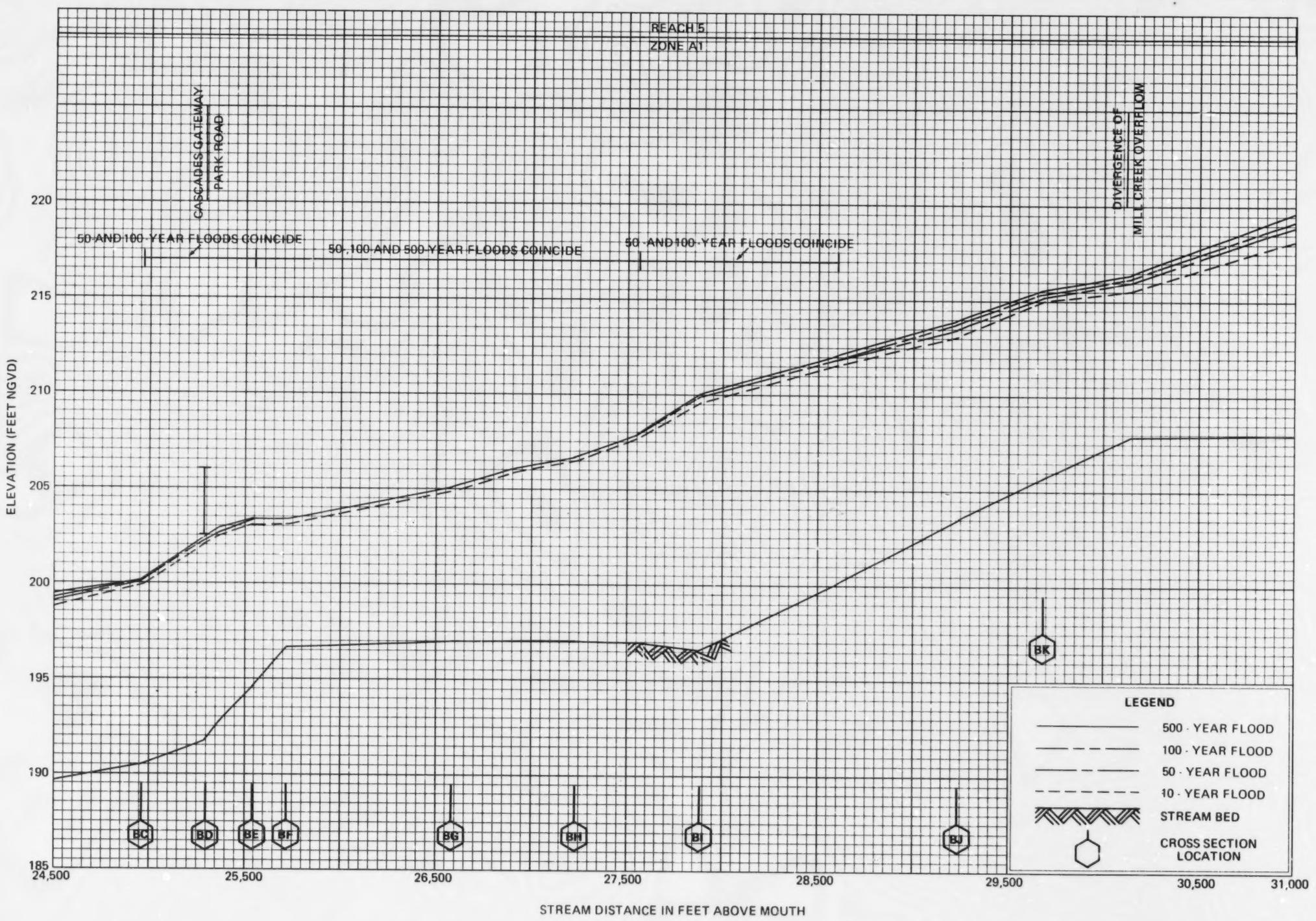

FLOOD PROFILES

MILL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

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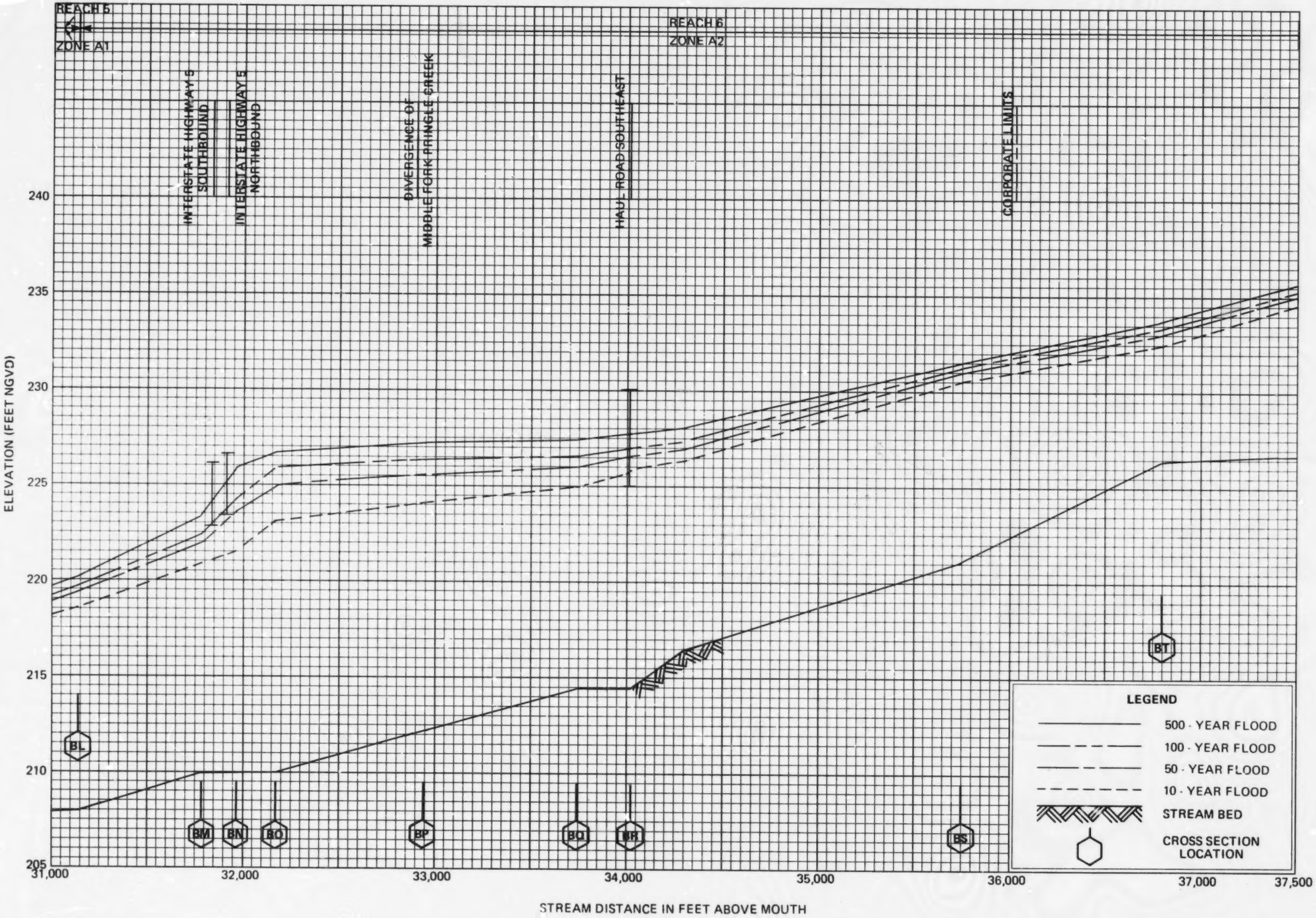

FLOOD PROFILES

MILL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

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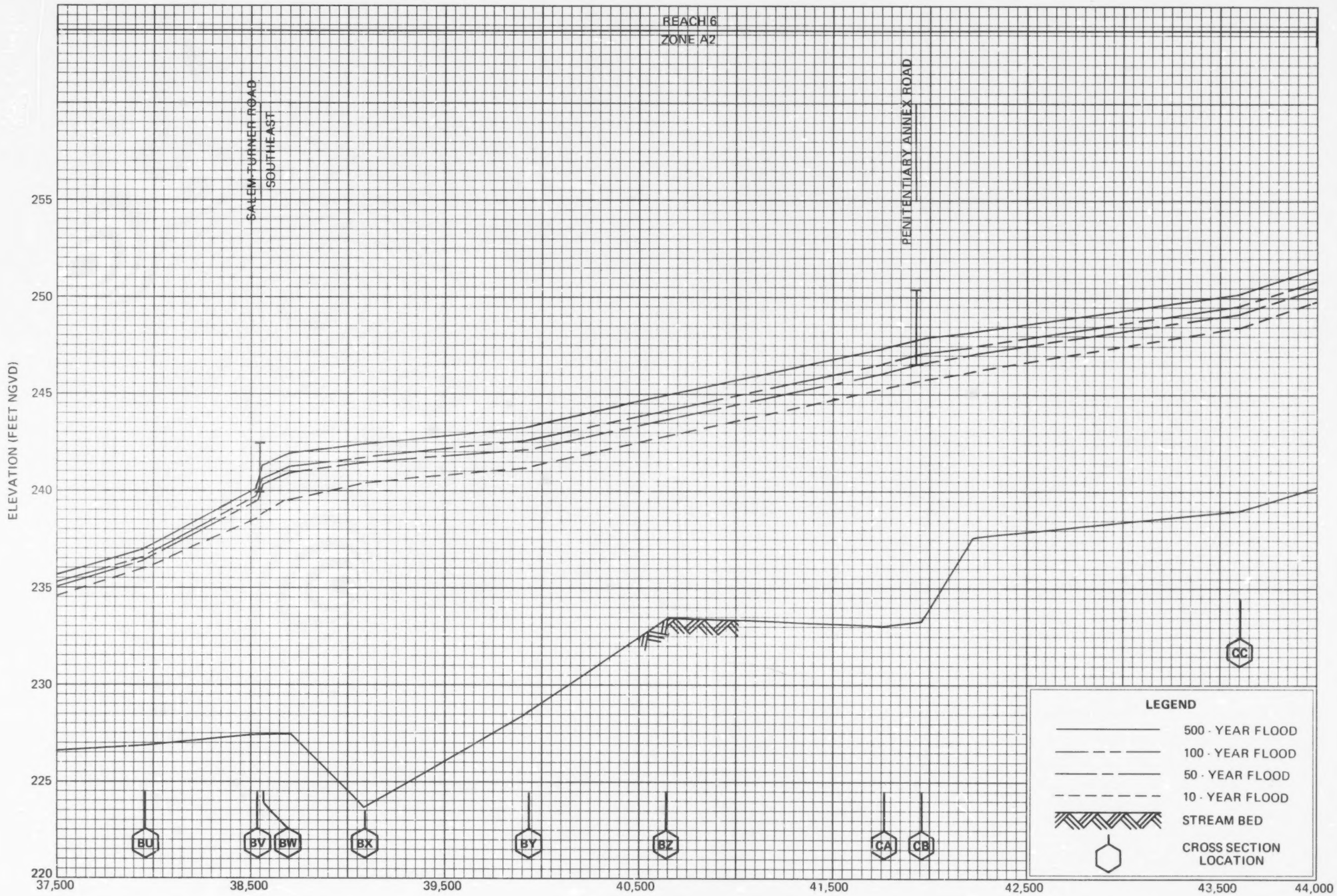

FLOOD PROFILES

MILL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR.
(MARION AND POLK COS.)

07P

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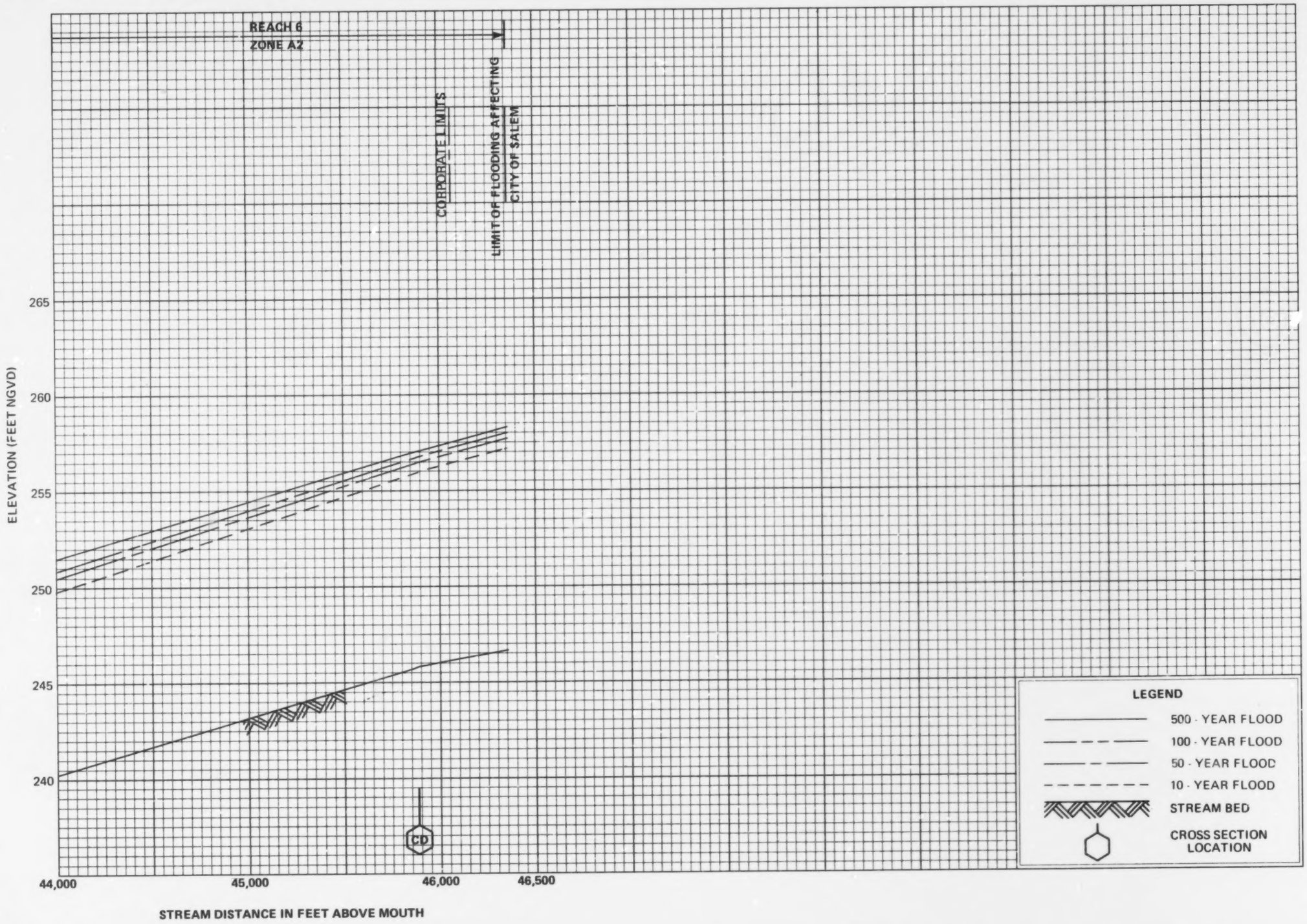

FLOOD PROFILES

MILL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

08P

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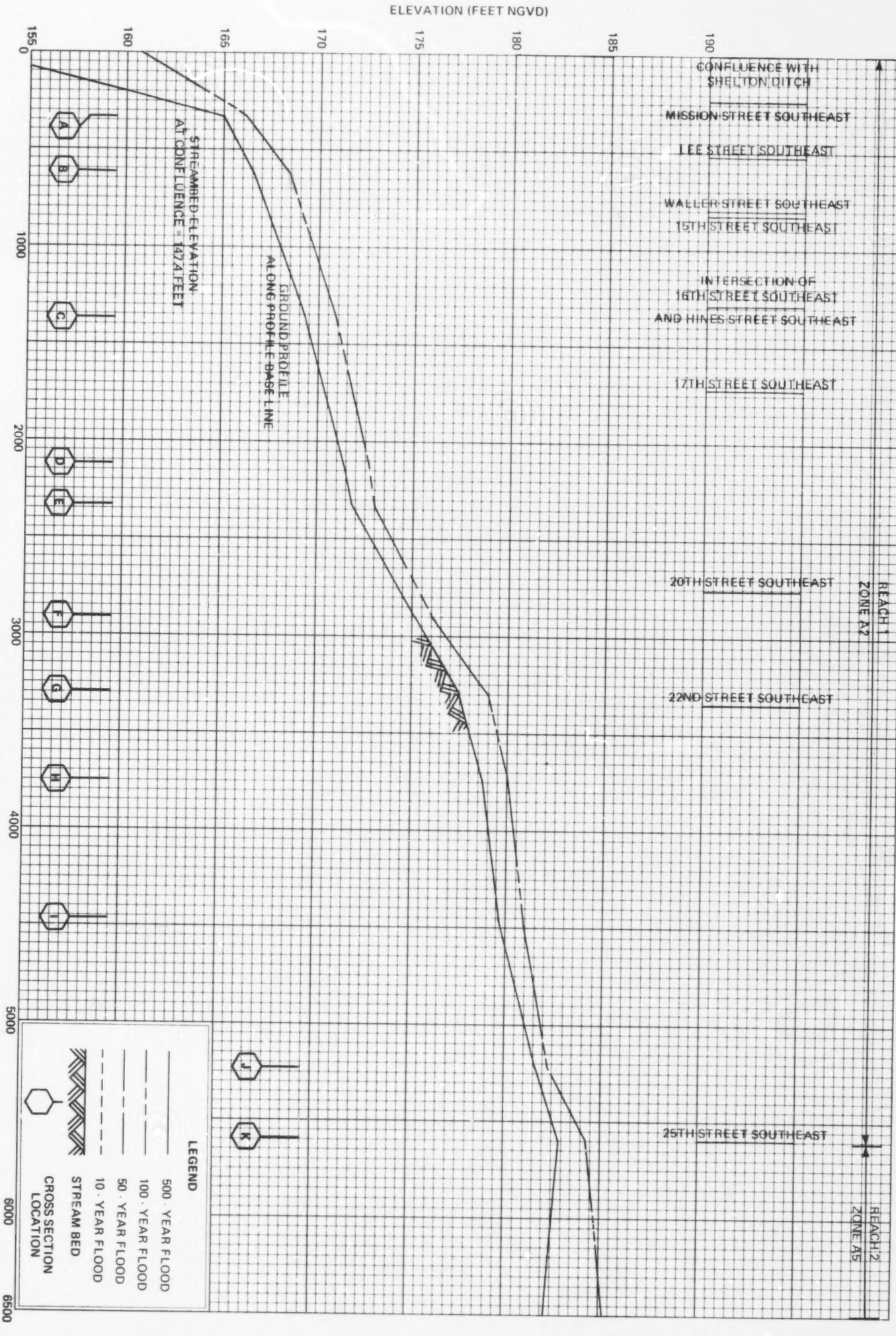

09P	FEDERAL EMERGENCY MANAGEMENT AGENCY CITY OF SALEM, OR (MARION AND POLK COS.)	**FLOOD PROFILES** MILL CREEK OVERFLOW(ALONG PROFILE BASE LINE)

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FLOOD PROFILES

MILL CREEK OVERFLOW(ALONG PROFILE BASE LINE)

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

10P

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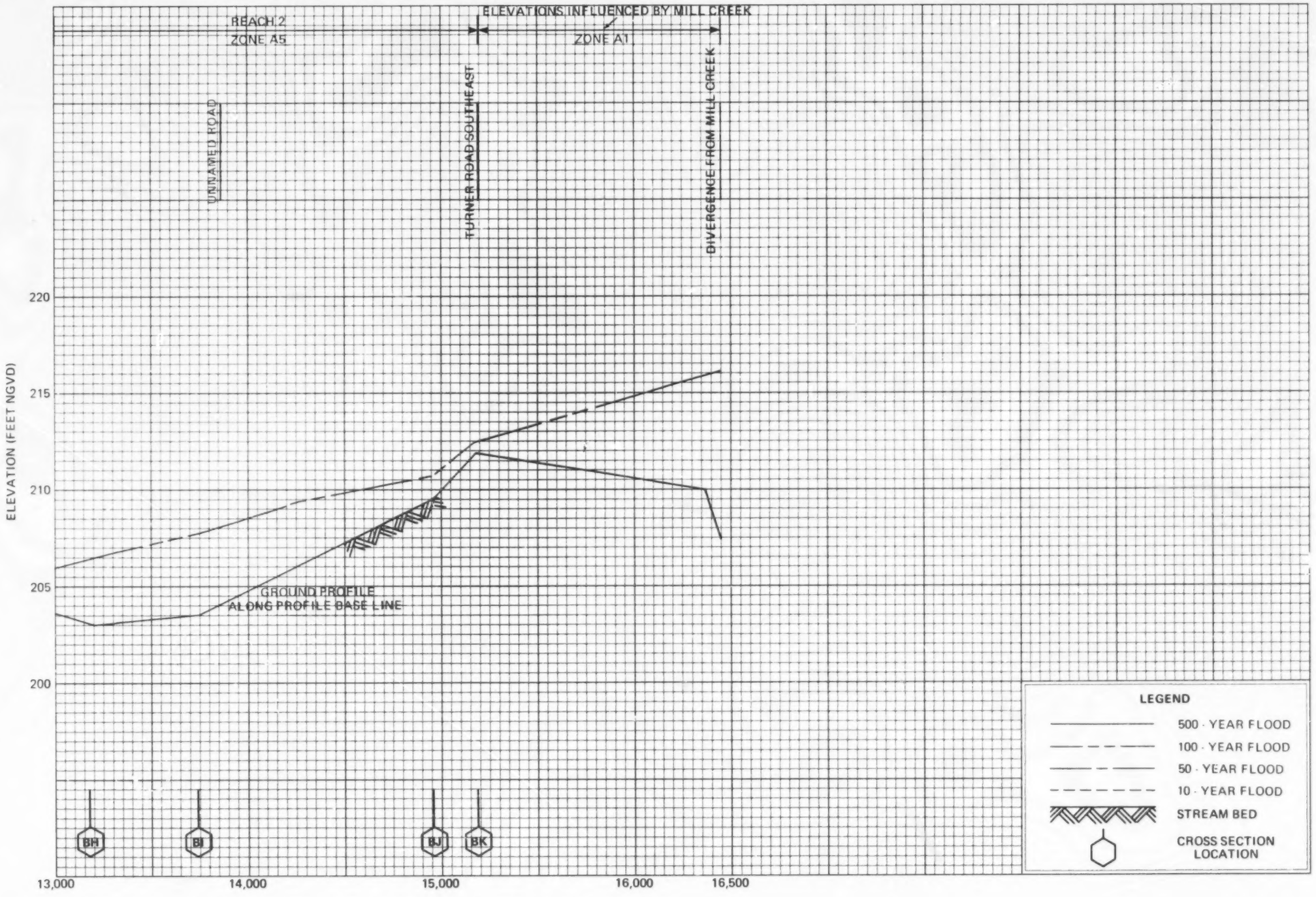

FLOOD PROFILES

MILL CREEK OVERFLOW(ALONG PROFILE BASE LINE)

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

11P

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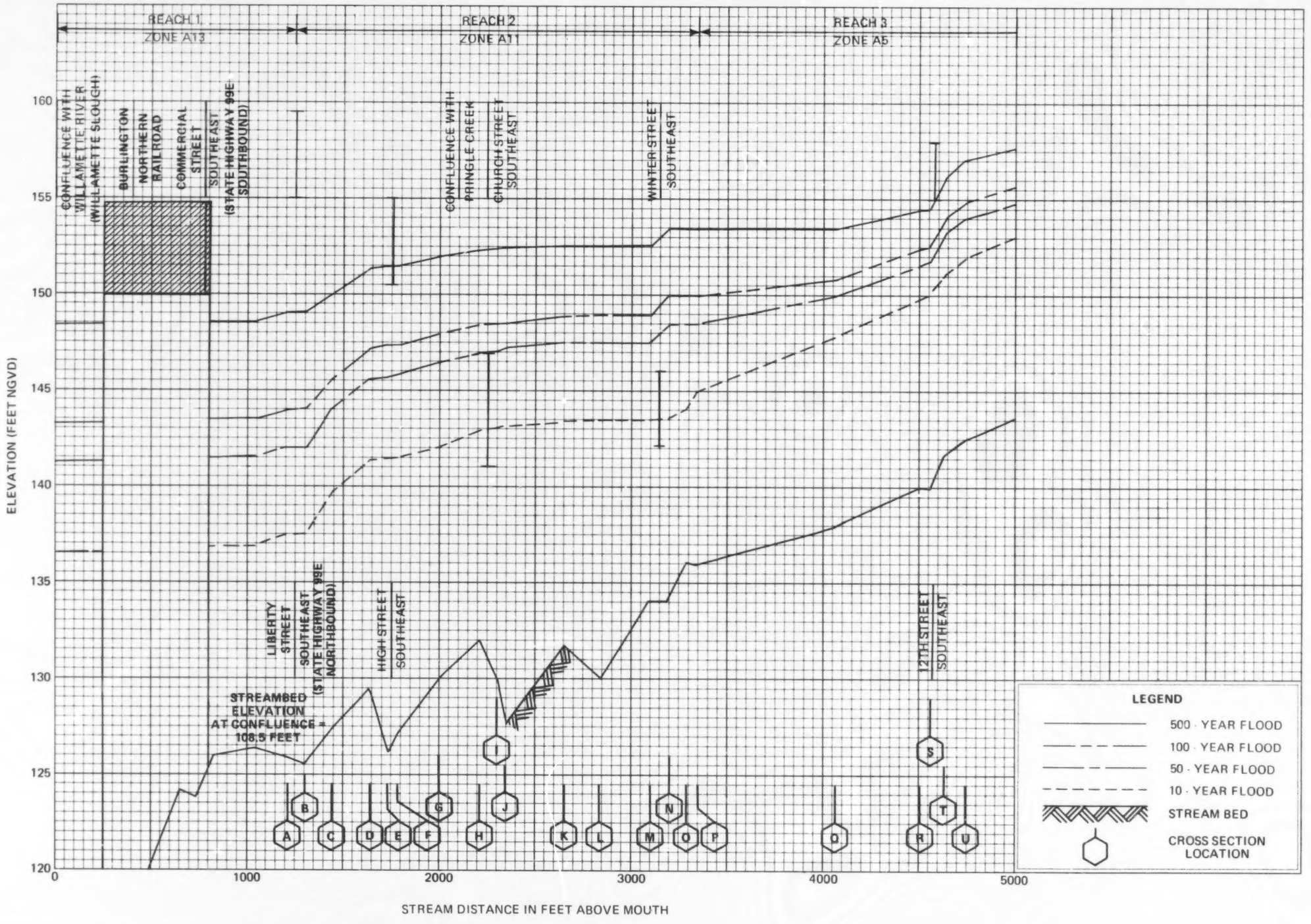

FLOOD PROFILES

SHELTON DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

12P

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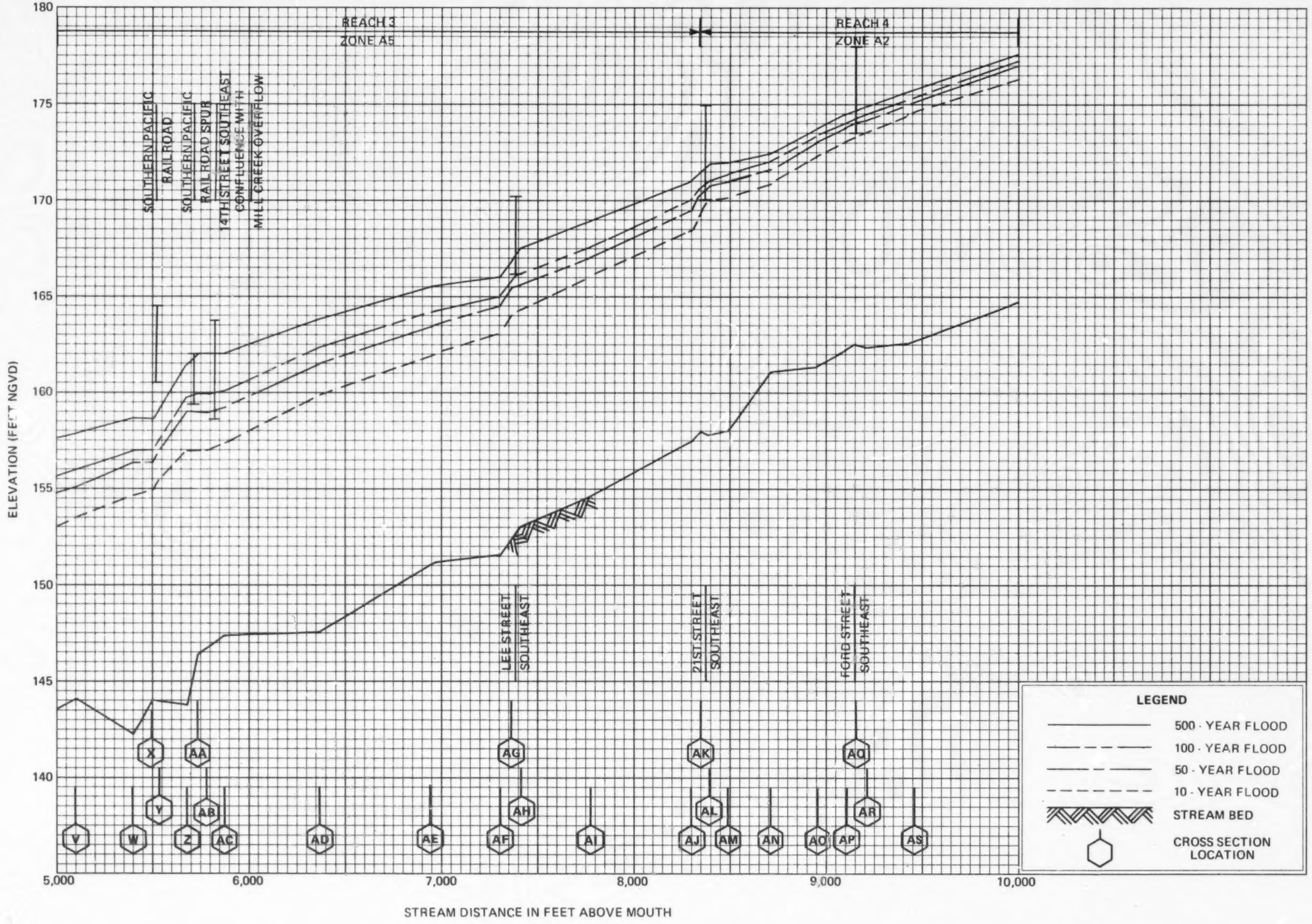

FLOOD PROFILES

SHELTON DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

13P

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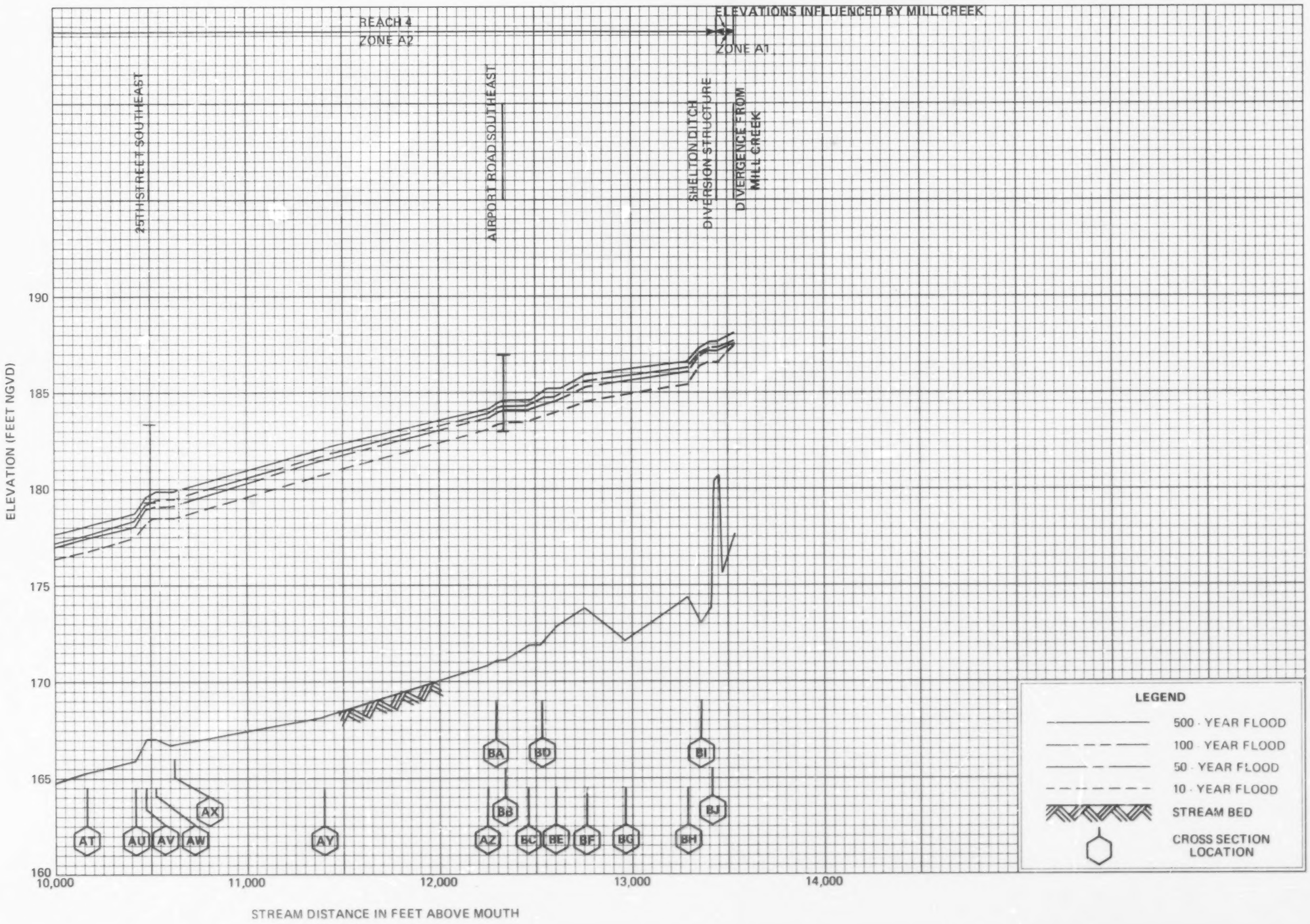

FLOOD PROFILES

SHELTON DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

14P

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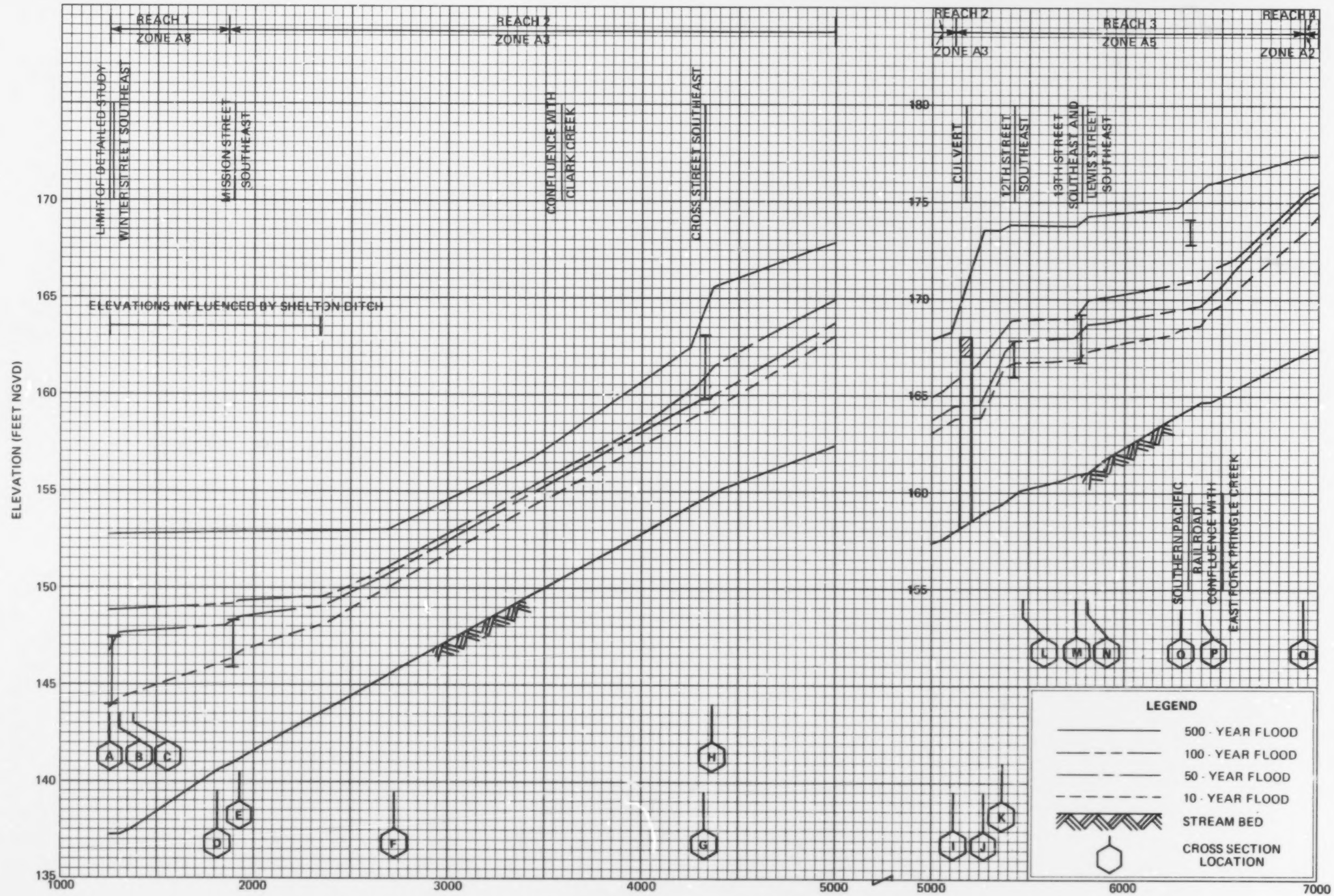

FLOOD PROFILES

PRINGLE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

15P

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REACH 4
ZONE A2

SOUTHERN PACIFIC RAILROAD SPUR

MCGILCHRIST STREET SOUTHEAST

SOUTHERN PACIFIC RAILROAD

CONFLUENCE WITH MIDDLE FORK PRINGLE CREEK AND WEST FORK PRINGLE CREEK

ELEVATION (FEET NGVD)

195
190
185
180
175
170
165

7,000
8,000
9,000
10,000
11,000
11,500

STREAM DISTANCE IN FEET ABOVE MOUTH

R S T U V W X Y

LEGEND
500 - YEAR FLOOD
100 - YEAR FLOOD
50 - YEAR FLOOD
10 - YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION

FLOOD PROFILES

PRINGLE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

16P

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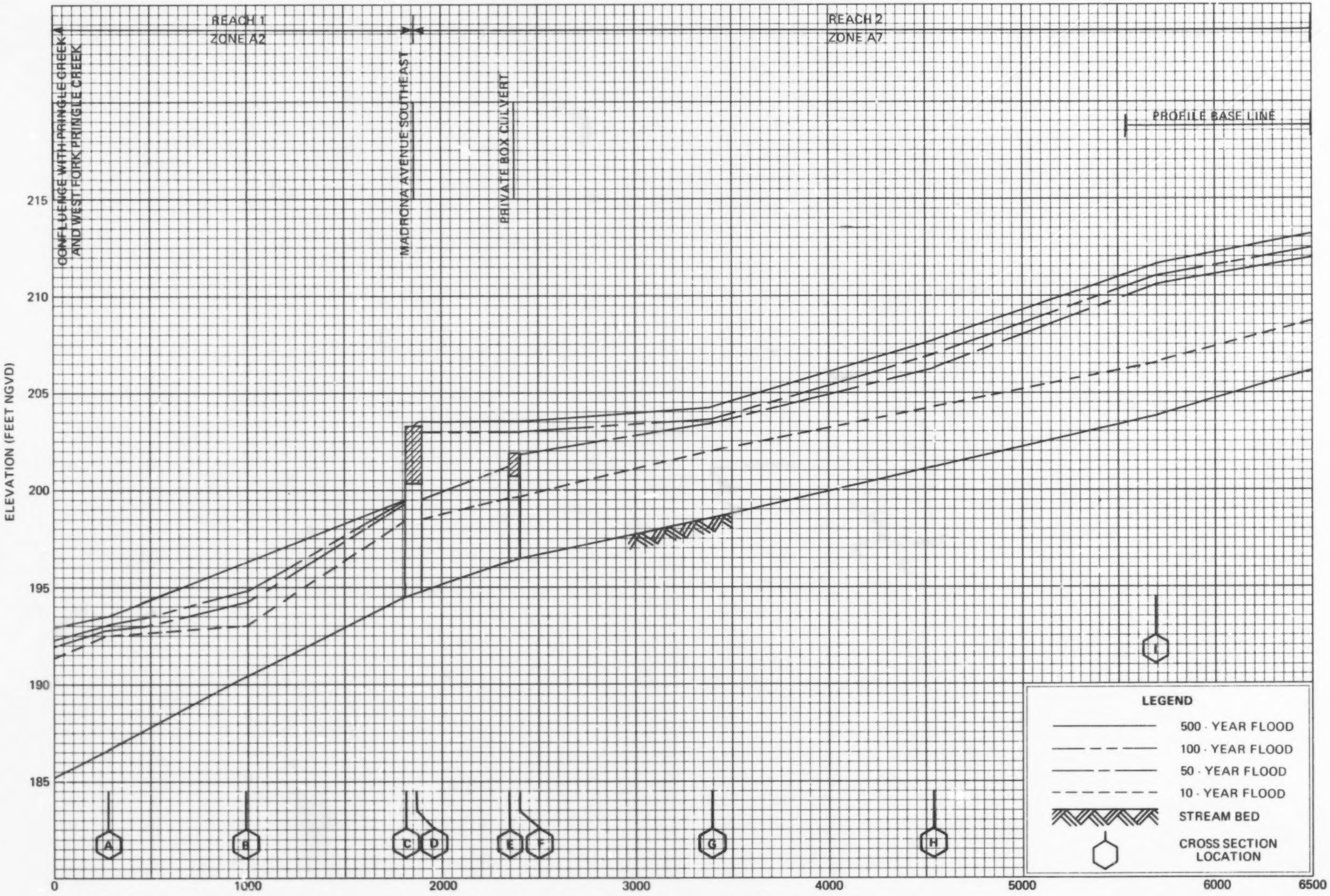

FLOOD PROFILES

MIDDLE FORK PRINGLE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

17P

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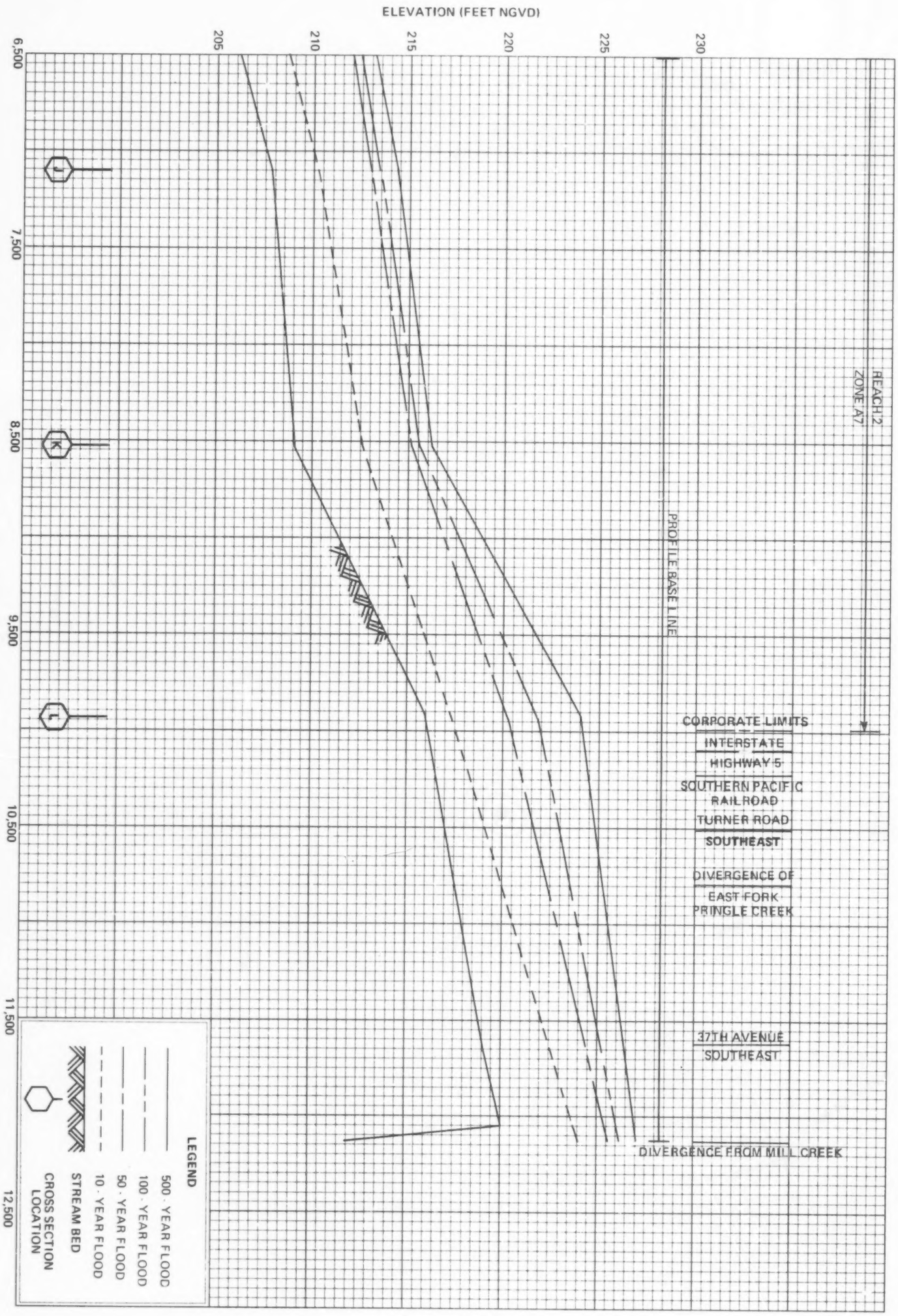

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

FLOOD PROFILES

MIDDLE FORK PRINGLE CREEK

18P

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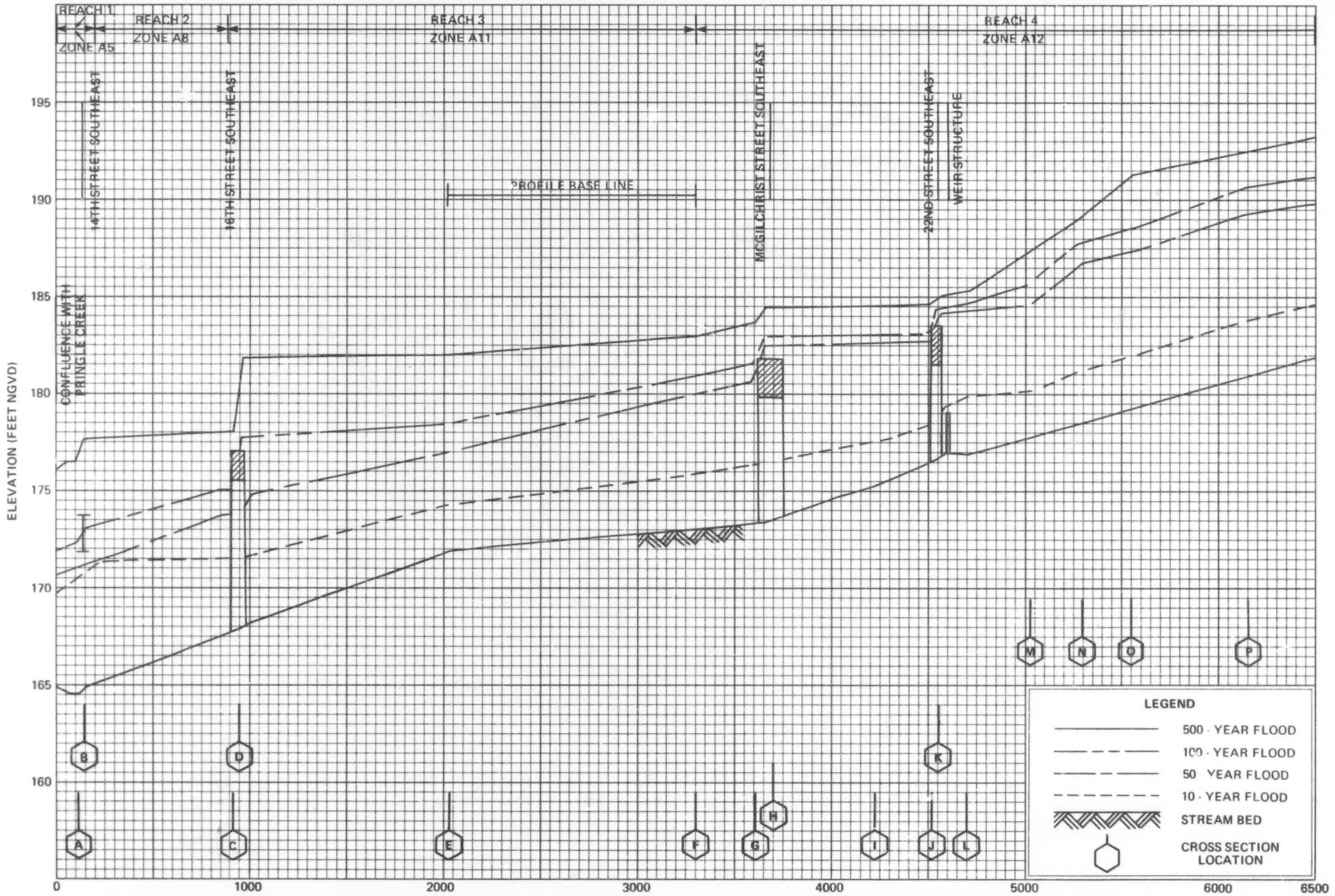

FLOOD PROFILES

EAST FORK PRINGLE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

'Y OF SALEM, OR
(MARION AND POLK COS.)

19P

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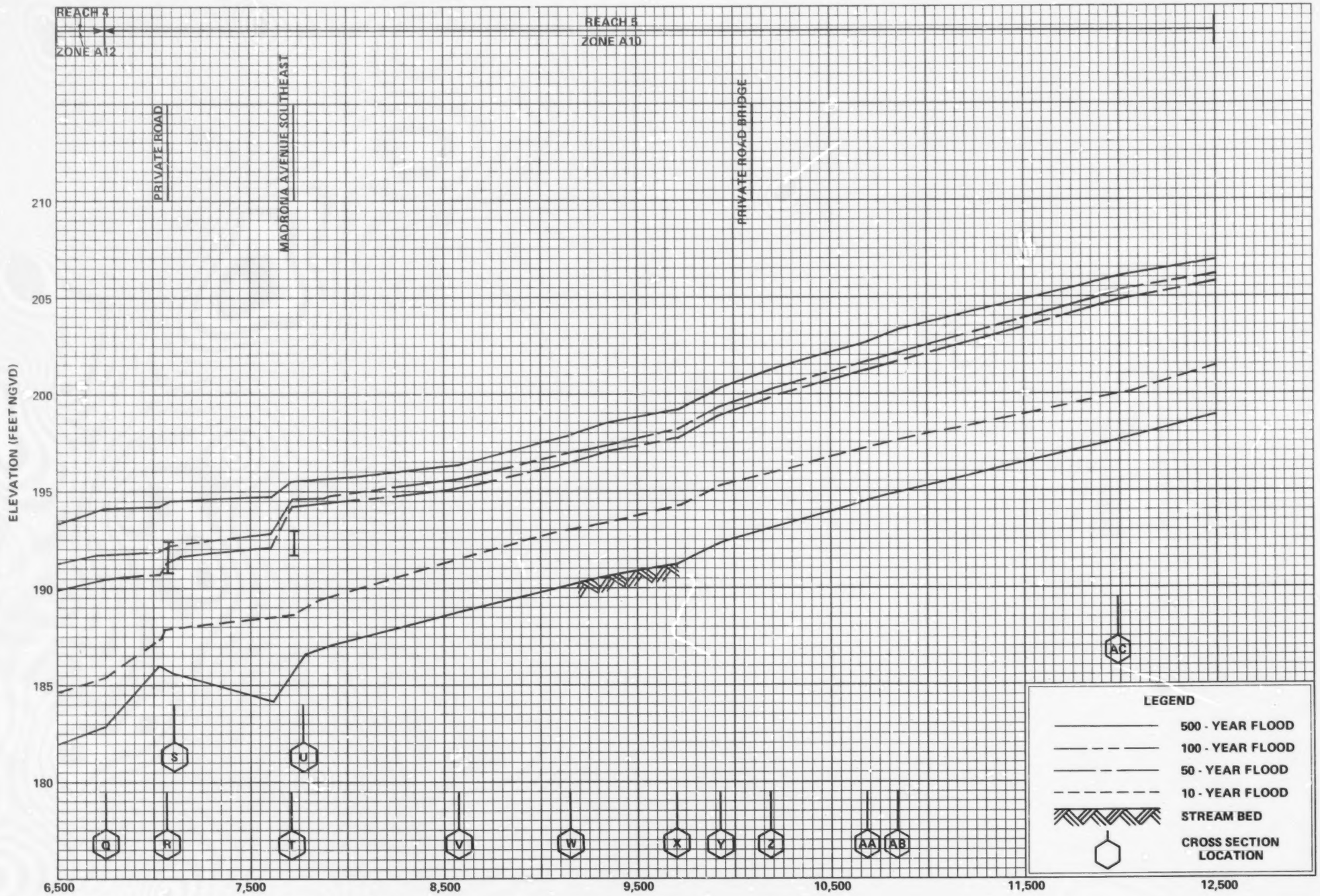

FLOOD PROFILES

EAST FORK PRINGLE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

20P

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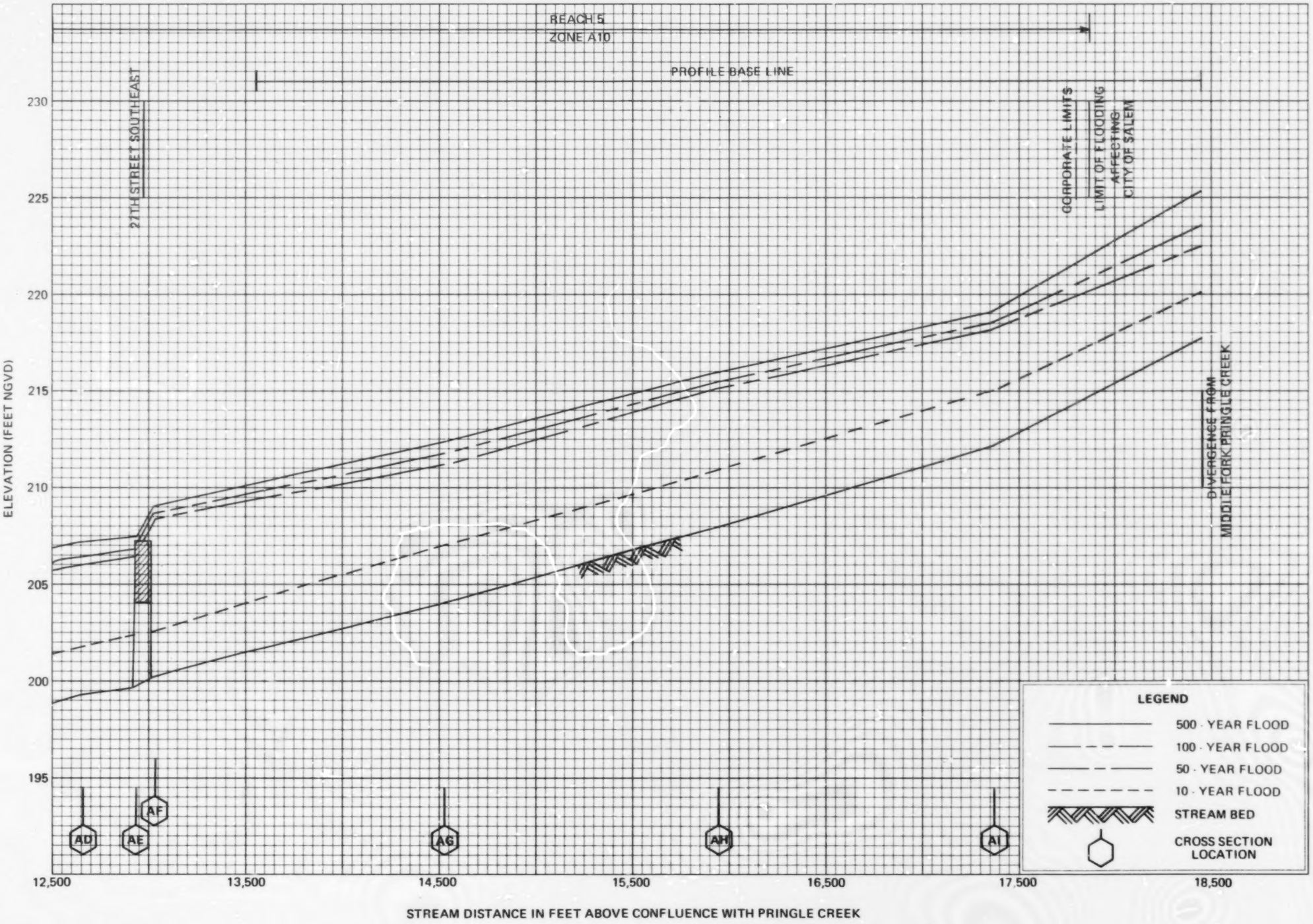

FLOOD PROFILES

EAST FORK PRINGLE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

21P

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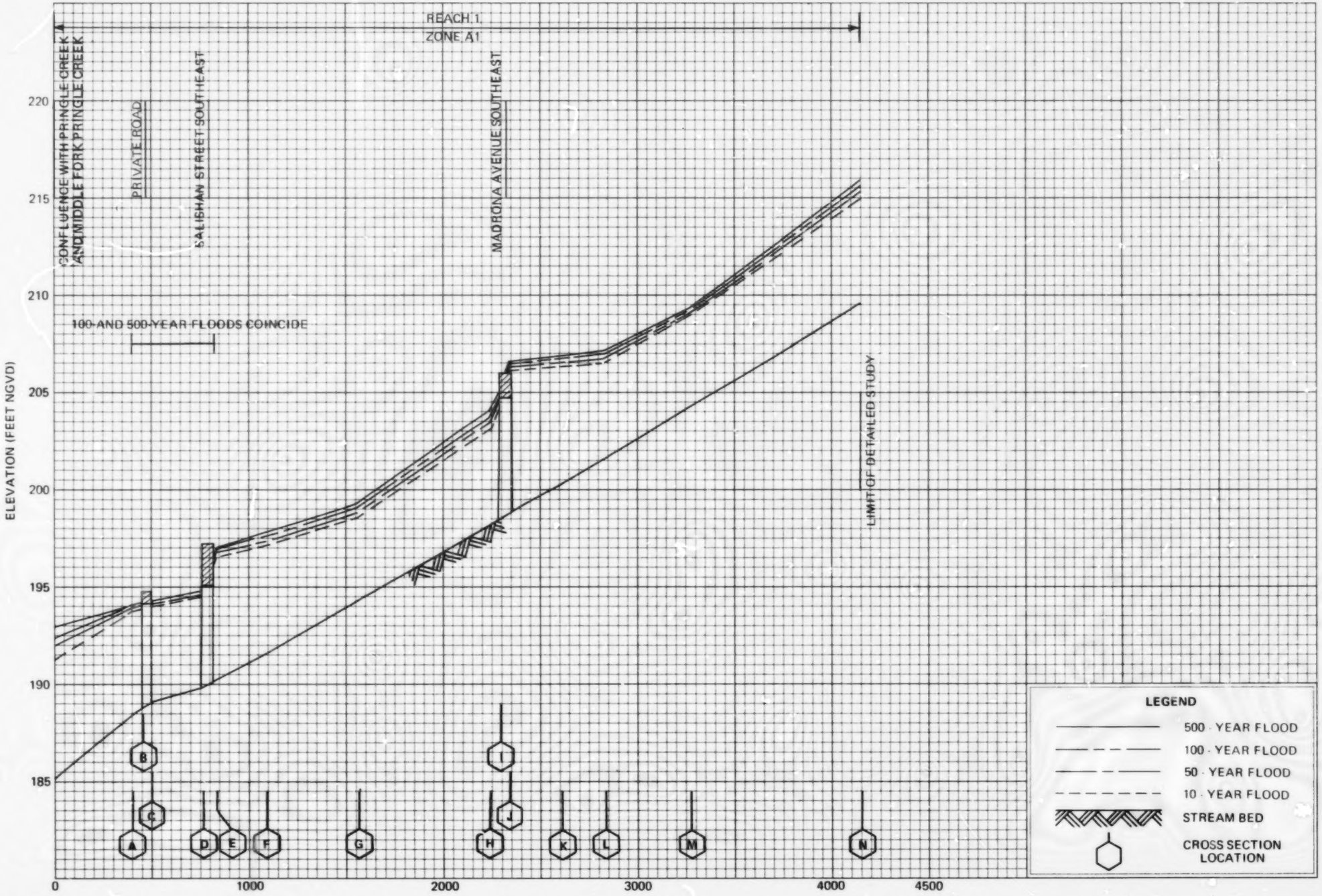

STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH PRINGLE CREEK AND MIDDLE FORK PRINGLE CREEK

FLOOD PROFILES

WEST FORK PRINGLE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

22P

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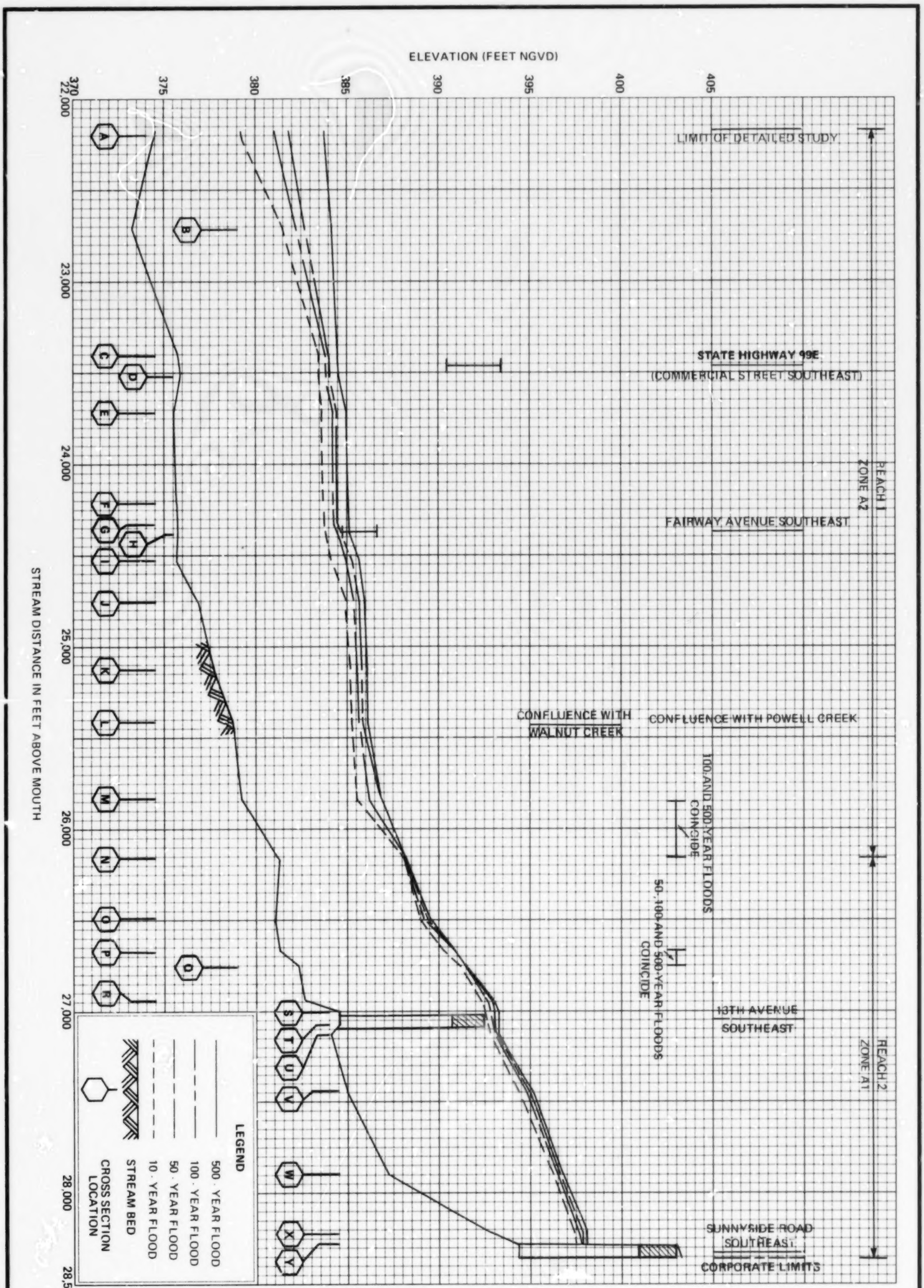
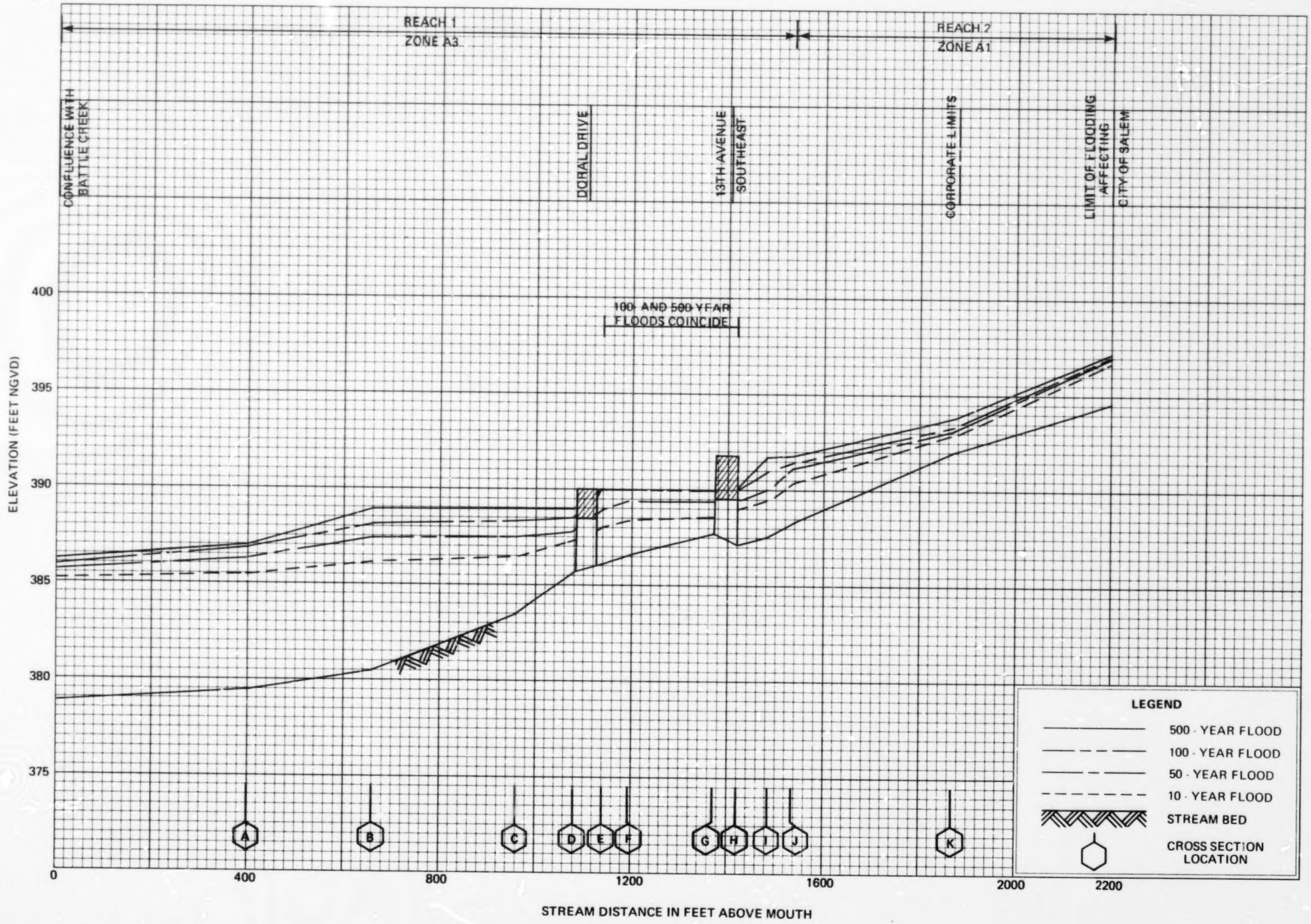


23P	FEDERAL EMERGENCY MANAGEMENT AGENCY CITY OF SALEM, OR (MARION AND POLK COS.)	FLOOD PROFILES BATTLE CREEK

BEST COPY AVAILABLE



FLOOD PROFILES

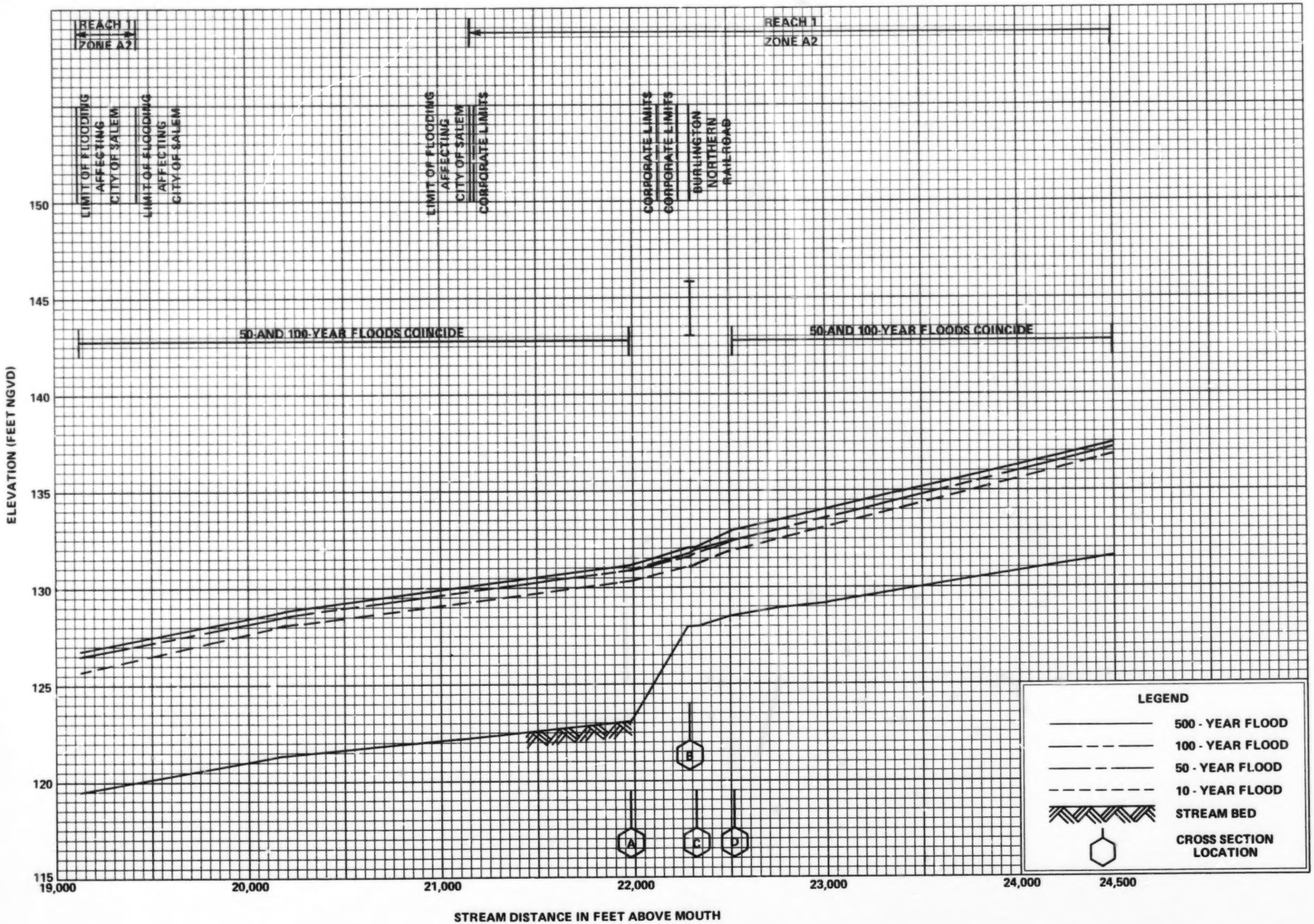
POWELL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

24P

BEST COPY AVAILABLE



FLOOD PROFILES

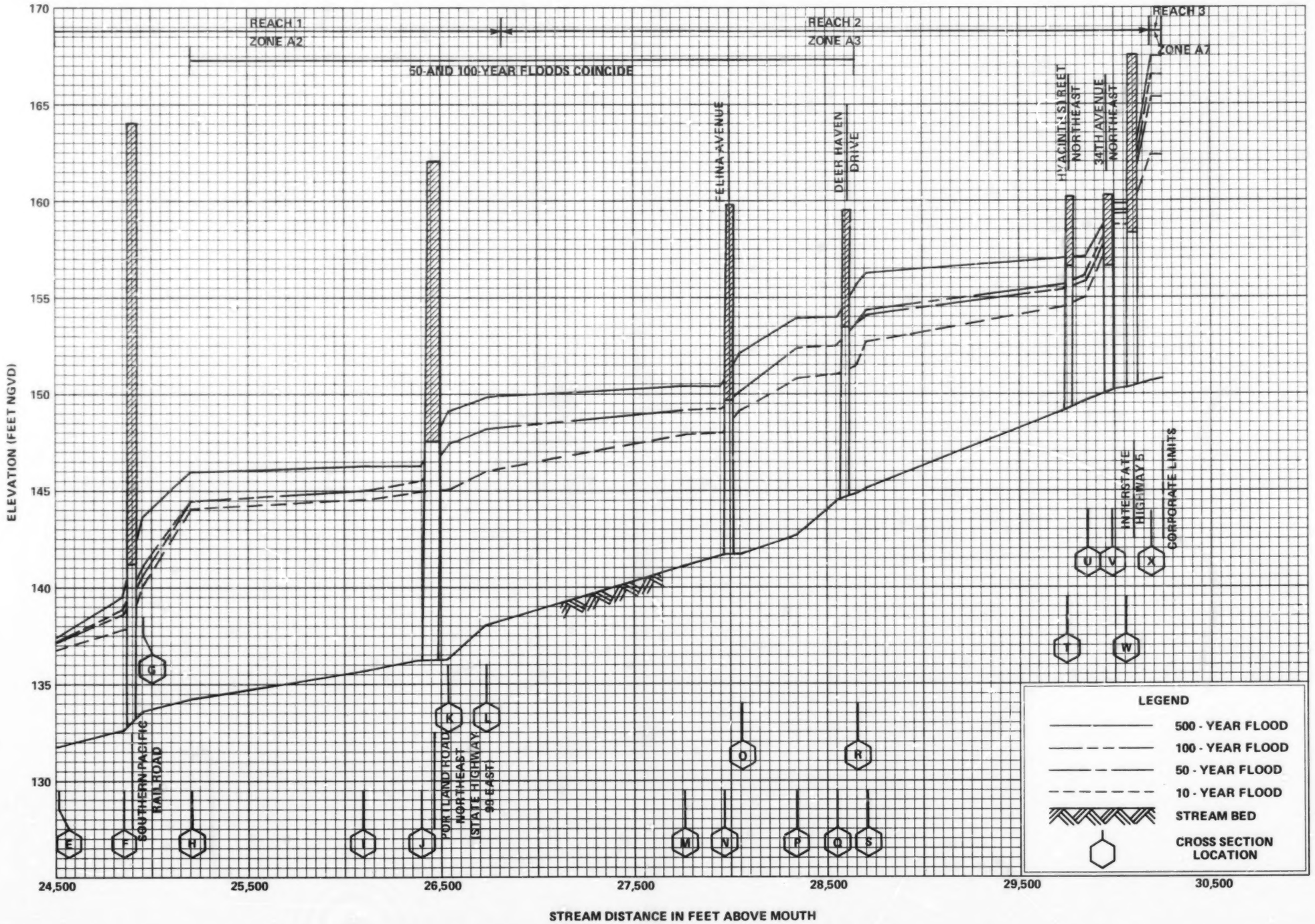
CLAGGETT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

25P

BEST COPY AVAILABLE



FLOOD PROFILES

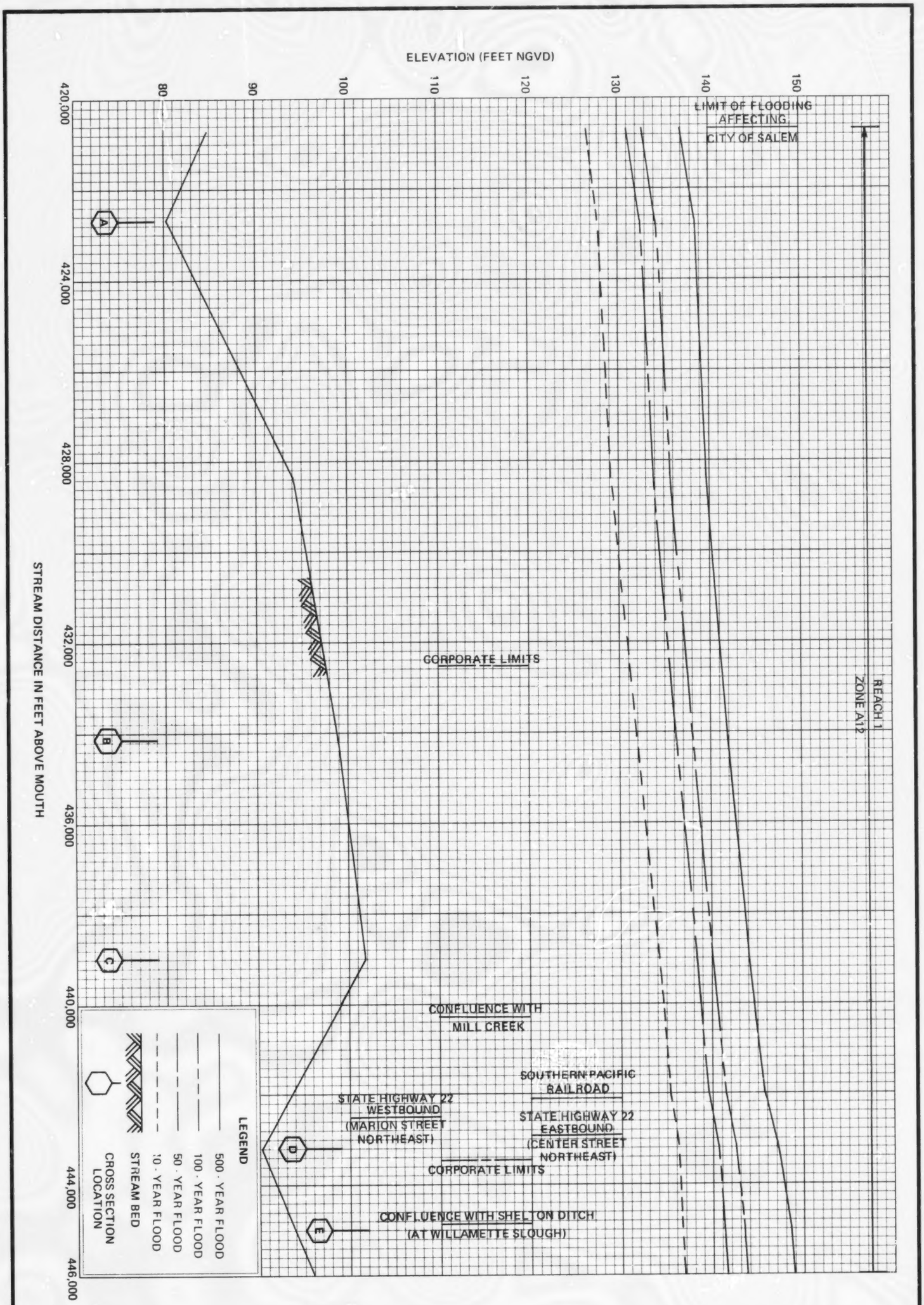
CLAGGETT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

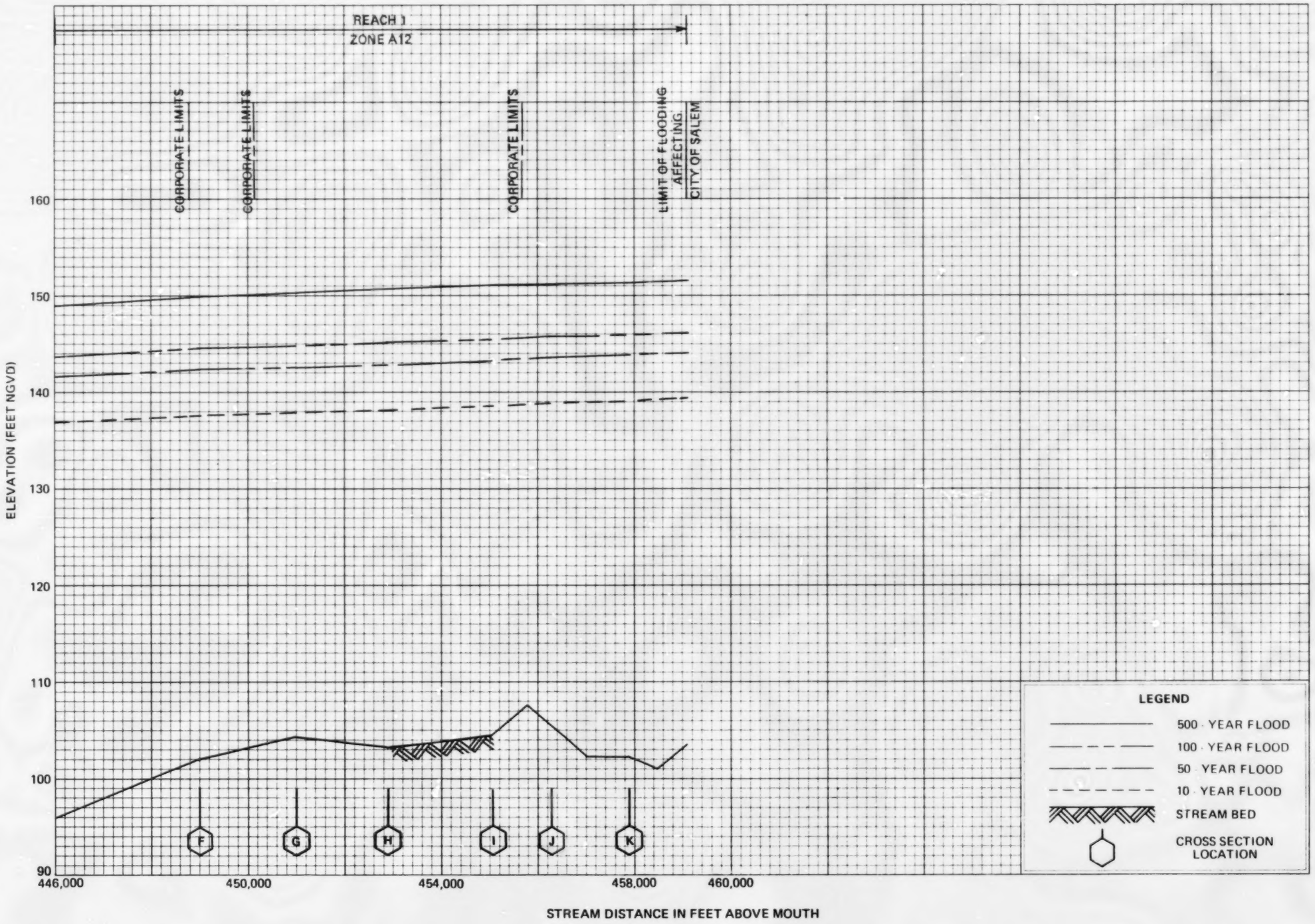
26P

BEST COPY AVAILABLE



27P	FEDERAL EMERGENCY MANAGEMENT AGENCY CITY OF SALEM, OR (MARION AND POLK COS.)	FLOOD PROFILES WILLAMETTE RIVER

BEST COPY AVAILABLE



FLOOD PROFILES

WILLAMETTE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SALEM, OR
(MARION AND POLK COS.)

28P

BEST COPY AVAILABLE